

Sacramento
Community Center
Complex
Specifications
Vol. 3

D I V I S I O N 15

MECHANICAL

SECTION 15A - MECHANICAL WORK - GENERAL REQUIREMENTS

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RELATED DOCUMENTS

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The general provisions of the contract, including General Conditions and Special Conditions, apply to the work specified in this section.

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DESCRIPTION OF WORK

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This section applies for all mechanical sections. All conditions and material are pertinent to the other section as if repeated in these sections.

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GENERAL

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Drawings: Examine all drawings prior to bidding of work and report any discrepancies in writing to the Architect.

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Verify all dimensions at the building site and check existing conditions before beginning work. Make changes which are necessary to install the work in harmony with other crafts; they shall be first approved by the Architect.

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Execute work mentioned in the specifications and not shown on the drawings, or vice versa, the same as if specifically mentioned in both.

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Code Rules and Safety Orders: Provide all work and materials in full accordance with the latest rules and regulations of the Safety Orders of the Division of Industrial Safety; the National Electric Code, the Uniform Plumbing Code, published by the Western Plumbing Officials Association; and other applicable laws or regulations. Nothing in these plans or specifications is to be construed to permit work not conforming to these codes. Furnish without extra charge, any additional material and labor required to comply with these rules and regulations.

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Fees and Permits: Procure and pay for all permits and licenses required.

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Framing, Cutting and Patching: Special framing, recesses, chases and backing for work of this Section is covered under other Sections. Be responsible for proper placement of all pipe sleeves, hangers and supports and location of openings for work of this section.

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Substitutions and Material List: Product names are used as standard only, other materials or methods shall not be used unless approved in writing by the Architect. The burden of proof as to the equality of any proposed material shall be upon the Contractor; Architect's decision is final. Only one request for substitution shall be considered for each item.

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Submit a list in 7 copies of materials for approval within 35 days after the award of the Contract. It shall be accompanied by shop drawings, pump performance curves, and other pertinent data, showing the size and capacity of the proposed materials. All materials to be used, whether

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substitutions or not, shall be listed in the order in which they appear in the specification.

Any mechanical, electrical, structural, or other changes required for the installation of any approved substituted equipment shall be made to the satisfaction of the Architect and without additional cost to the Owner. Approval by the Architect of the substituted equipment and/or dimensional drawings does not waive these requirements. Upon request, submit drawings of mechanical equipment spaces showing substituted equipment before installation.

Approval of material shall not be construed as authorizing any deviations from the specifications unless the attention of the Architect has been directed to the specific deviations.

Furnish to the inspector, upon request, complete installation instructions on all material and equipment before starting installation of same.

Site Conditions: Information on the drawings relative to existing conditions is approximate only. Deviations found necessary during progress of construction to conform to actual conditions, as approved by the Architect, shall be made without additional cost to the Owner. The contractor shall be held responsible for any damage caused to existing utilities. Promptly notify the Architect if utilities are found which are not shown on the drawings.

Guarantee: Refer to City of Sacramento, "Standard Specifications," Section 6 for Guarantee.

Electrical Requirements: Provide adequate working space around electrical equipment in compliance with the California Administrative Code, Title 8, Electrical Safety Orders, Article 18 of the State of California. Coordinate the Mechanical Work with the Electrical Work to comply.

Furnish and set in place all motors. Verify the location of all switches with the Architect before roughing in. Furnish necessary control diagrams and instructions for the controls.

Before permitting operation of any equipment which is furnished, installed or modified under this section, review all associated electrical work including overload protection devices and assume complete responsibility for the correctness of the electrical connections and protective devices.

Motors and control equipment shall conform to the Standards of the National Electrical Manufacturer's Association. All equipment and connections exposed to the weather shall be NEMA IIIIR with factory wired strip heaters in each starter enclosure where required.

All wiring, conduit, fuses, thermal overloads and disconnect switches, connection of all motors and controls, both line and low voltage, is under Electrical Work.

Electric Motors: Shall be Sterling, Lincoln, or equal, selected for quiet operation. All motors shall be rated for continuous operation at 115% of nameplate amperage but shall be selected to operate at less than nameplate amperage throughout the entire operating cycle. Motors found exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepowers shown are minimum and shall be increased as necessary to comply with above requirements. Furnish motors with splash proof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check electrical drawings. Provide a transformer for each motor not wound specifically for system voltage.

Motor Starters: Furnish magnetic motor starters for all equipment furnished under this Section except those shown in motor control centers. Furnish starters with the proper size thermal overload units, ambient compensated. Provide 3 phase motor starters with 3 overloads.

Magnetic starters shall have Hand-Off-Automatic switches furnished integral with the starter when starter is serving an automatically controlled motor. Starter shall be Square D, Allen Bradley, or equal, in NEMA Type I enclosures, unless otherwise specified or required.

Excavating: Perform all excavating required for work of this Section. Unless shown otherwise, provide a minimum of 2'-0" above top of pipe to finished grade outside and a minimum of 1'-0" under building from bottom of slab. Trim trench bottom by hand or provide a 4" deep minimum bed of sand to provide a uniform grade and firm support throughout entire length of pipe. For insulated pipe or cement asbestos pipe, bed the pipe in sand.

Maintain all warning signs, barricades, flares and red lanterns as required.

Backfilling: Backfill shall be in compliance with applicable provisions of Division 2 of these specifications.

Replace or repair to its original condition all sod, concrete, or other materials, including landscape sprinklers, disturbed by the trenching operation. Repair within the guarantee period as required.

Thrust Blocks: Provide concrete anchors or thrust blocks on all cast iron and cement asbestos water lines in the ground. Install thrust blocks at all changes in direction, and at all connections to the mains 2" and larger. Form thrust blocks by pouring concrete between the pipes and trench wall. They shall be adequate in size and placed to take all thrusts created by the maximum internal water pressure.

Tests and Adjustments: Test the installations in accordance with the following requirements and all applicable codes.

Notify the Architect at least 7 days in advance of any test.

All piping shall be tested at completion of roughing-in, or at other time as directed by the Architect.

Furnish all necessary materials, test pumps, gases, instruments and labor required for testing. Tests shall be witnessed by the Architect.

Test Schedule: (No loss in pressure or visible leaks shall show after 4 hours at the pressures indicated.)

<u>System Tested</u>	<u>Test Pressure PSI</u>	<u>Test With</u>
Sanitary Sewer, Drain, Vent		
Storm Drain, Condensate drains	Rill to top of highest vent	Water
Storm Drain	10 ft.	Water
Domestic Hot and Cold Water	150	Water
Dry & Wet Standpipes	300	Water
Gas	100	Air & Soap
Compressed Air, except controls	250	Air & Soap
All Hot, Chilled, Condenser Water Piping, up to 15 Psi		
Steam piping, & all steam condensate piping	150	Water
Steam Piping above 15 psi	300	Water
All steam piping shall be tested with normal pressure steam before insulating. Cement asbestos pipe shall be filled with water for one hour prior to test.		
All piping, including underground, connected to the fire sprinkler system shall be tested and certified in accordance with Pacific Fire Rating Bureau requirements.		
Perform operational tests under simulated or actual service conditions, including one test of complete plumbing installation with all fixtures and other appliances connected and one test of complete installation of 8 hours each for heating and cooling with all equipment connected and operating.		
Should any material or work fail in any of these tests, it shall be immediately removed and replaced by new material, and portion of the work replaced shall again be tested by Contractor at his own expense.		
Instruct Owner's operating personnel during operating adjustment period. Lubricate each item of equipment, including motors, before operation.		

MATERIALS AND EQUIPMENT

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Materials or equipment of the same type shall be of the same brand
wherever possible. All materials shall be new.

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Pipe Joints and Connections:

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Cutting: Cut pipe and tubing square, remove rough edges or burrs.

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Threaded Pipe: Make joints with Bakerseal thread lubricant, use no
caulking of any kind, remake leaky joints with new materials. Victaulic
style 77 fittings may be used where accessible above ground in lieu of
screwed fittings on water piping operating at temperatures of 140°F. or
less, gaskets and fittings shall be thoroughly lubricated. Victaulic
Style 77 fittings may be used on heating system piping (with correct
gasket for temperature) where accessible in mechanical rooms.

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Copper and Brass Pipe and Tubing (except Control Piping): Make all
joints with silver brazing alloy, Silfos or equal, 1100° F. melting
point or greater, ASTM B-260, except that water piping 1-1/4" and
smaller not buried in the ground or concrete and type D.W.V. plumbing
piping may be made up with 95-5 tin-antimony, ASTM B-32, Grade 5A,
solder. Boss type fittings will not be allowed.

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Cast Iron Soil Pipe: Make joints with oakum and lead. Wrought iron,
steel, or copper pipe shall have a ring or part of a coupling screwed
on to form a spigot end if caulked into a joint.

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Ty-Seal, or equal, pipe and fittings with neoprene gaskets may be used
at the Contractor's option. No-Hub pipe and fittings may not be used.

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Connect cast iron sewer piping to outside service pipe with cast iron or
vitrified clay reducers or increasers as required. Caulking of smaller
pipe into the larger without a reducer or increaser will not be permitted.

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Clay Sewer Pipe: Joints in bell and spigot clay sewer pipe shall comply
with ASTM C-425, made with an approved type of interlocking, resilient
mechanical compression joint, formed on the pipe at the factory. Lubricate
inside of bells and outside of spigots with a solution as recommended by
the pipe manufacturer.

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Welded Pipe: Make up with oxyacetylene or electric arc process.

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All welding shall conform to the American Standard Code for Pressure
Piping ASA B-31, Section 6, Chapter 4, and Appendix A. When requested by
the Architect, furnish certification from an approved testing agency or
National Certified Pipe Welding Bureau that the welders performing the
work are qualified.

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All line welds shall be of the single "V" butt type. Welds for flanges
shall be of the fillet type.

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Where the branch is 2 pipe sizes smaller than the main or smaller, Bonney
Weldolets, threadolets, Nibco, or equal, may be used in lieu of welding
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Asbestos-Cement Pipe: Make joints in water pipe with asbestos-cement sleeves and rubber rings. Check final location of rubber rings within the couplings by gauge as recommended by the manufacturer.

Make joints between asbestos-cement pipe and cast iron pipe or fittings, valves or hydrants with cast iron adapter fittings, installed as recommended by the manufacturer.

Valves and Fittings:

Valves: Shall be Crane, Walworth, Nibco, Homestead, or equal.

		For Steam Above 15 psi	
Gate Valves 2-1/2" and smaller	Crane #430	Crane #459	
Gate Valves 3" and larger	Crane #460	Crane 3 E	
Globe Valves 2-1/2" and smaller	Crane #7	Crane 382 P	
Globe Valves 3" and larger	Crane 351	Crane 151 XR	
Angle stop and check		Crane 30E	
Check valves 2-1/2" and smaller	Crane 34 Muessco #203 BP	Crane 76E	
Check valves 3" and larger	Crane 373 Muessco #105 AP	Crane 159 X	
Sewage check valves	Crane 383 with outside lever and weight		
Gas Cocks	Homestead 611, 612		
Gas Cocks at appliances	Walworth #597		
O S & Y Gate Valves 2" & smaller	Crane #459		
O S & Y Gate Valves 2-1/2" & larger	Crane #467		
Gas Pressure Regulating Valves, Reliance 1303 or 2003, Rockwell or equal.			

Valves in the ground shall be nut operated with Alhambra Foundry Co. #A-3004, Brookes, or equal, access boxes marked for service. Provide a tee handle wrench for each size. Set access boxes in 4" thick concrete pad, trowel smooth and edge, set flush with grade.

Provide proper composition discs for all angle and globe valves for the fluid being controlled. Lubricate plug valves as recommended by manufacturer for service and temperature.

Valves in copper lines shall be furnished with adapters, or may be solder joint type of equal quality to screw type valves.

Hand Valves: Crane #2330 TB ball valves through 2" for Demco series L butterfly valve. Provide EPT seats. Hand valves may be used in lieu of gate valves except in ground.

Balance cocks or Valves: Sarco IBW or Dunham Bush #840 mil-balancer through 1", Homestead Fig. 601 for 1-1/4" through 2", Homestead Fig. 602 for 2-1/2" through 6", Fig. 602A above 6". Handles (above 1") shall be infinite throttling with indicator and memory stop.

Relief: Scott #150, bronze body and trim, McDonnell and Miller, or Watts, unless noted, pipe discharge of each valve separately to floor sink or drain.

Air Vent: Hoffman #79 where automatic type is shown. Install with shut-off valves or cocks and drain to a floor sink or drain. Provide Lunkenheimer #1178-3/8" cock at 5'-0" above floor for manual air vent at each high point of piping, pipe drain to floor sink or drain.

Vacuum Breakers: SMR #P-701 (1/2" to 1"), #P-711 (1-1/4" - 2"), P-714 (2" and larger) with check valves, pressure type. SMR #H-400 (1/2"), #H-403 (3/4") atmospheric type.

Steam Traps: Armstrong, Model 15 up to 15 psi, Model 30 up to 30 psi, Model 75 up to 75 psi.

Lift Fittings: Webster, Figure 24, maximum height of each lift shall be 5'-0". Each lift shall have an inverted trap at the top, 2" minimum above connected return pipe.

Flow Control Valves: Bell & Gossett circuit setter through 3".

Flow Balancers: Bell and Gossett circuit sensor for 4" and larger.

Shut-Off Valves: Homestead #601 through size, #602 for 2-1/2" through 6", Fig. 602A above 6".

Unions and Flanges: Install Epco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain, waste, vent, or rainwater piping.

Install unions whether shown or not at each connection to all equipment and tanks, at one connection to each valve or cock and at all connections to all automatic valves, such as temperature control valves.

Locate the unions for easy removal of the equipment, tank, or valve; they shall be of the following type:

<u>Type of Pipe</u>	<u>Union</u>	
Steel 2" & smaller	150 pound screwed black or galvanized malleable iron, match pipe, ground joint, brass to iron seat.	14 15 16
Steel 2-1/2" & larger	150 pound black flange union, flat faced, full gasket.	18 19
Copper or brass pipe or tubing 2" & smaller	150 pound cast bronze ground joint, bronze to bronze seat, with copper to copper and connections.	21 22 23
Copper or brass pipe or tubing 2-1/2" & larger	150 pound brass flange union, flat faced, gasket	25 26
<u>Gaskets:</u>		28
Cold Water --	1/16 inch thick rubber Garlock No. 122, Johns Manville, or equal.	30 31
Hot Water or Steam --	1/16 inch compressed asbestos Garlock No. 7022, Johns Manville, or equal.	33 34
<u>Flange Bolts:</u> Open-hearth bolt steel, square heads, with cold pressed hexagonal nuts, cadmium plated in ground. Provide copper plated steel bolts and nuts or brass bolts and nuts for brass flanges.		36 37 38
<u>Pipe Protection:</u>		40
Wrap bare galvanized or black steel pipe, or copper pipe, buried in the ground and to 6" above grade, including piping in conduit, with one of the following:		42 43 44
<u>Polyethylene Coating:</u> X-Tru-Coat, or equal extruded polyethylene coating with Raychem "Thermofit," or equal, polyethylene sleeve joints.		46 47 48
<u>Tape Wrap:</u> Pressure sensitive polyvinyl chloride tape, "Trantex #V-10 or V-20", "Scotchrap #50" or equal, with continuous identification. Tape shall be a minimum of 10 mils thick for fittings and irregular surfaces, 2 wraps, 50% overlap, 40 mils total thickness; 20 mils thick on pipe with 50% overlap, 40 mils total thickness. Tape shall be laminated with a suitable adhesive. Widths as recommended by the manufacturer for the pipe size. Wrap 50'-0" or longer sections of piping with an approved wrapping machine.		50 51 52 53 54 55 56 57

Pabco Wrap: Pabco Specification #D-40-240K double wrap, in accordance with manufacturer's recommendations. Lap pipe wrap a minimum of 1/4" and stagger the second layer. Maintain the floating at 340° F. All Pabco pipe wrapping shall be done by the manufacturer's agent and not by the Contractor, except the field joints.

Field Joints and Fittings: Pabco double wrap or Polyvinyl Chloride tape as above. Provide at least 2 thicknesses of tape over the joint and extend a minimum of 4" over adjacent pipe covering. Build up with primer to match adjacent covering thickness.

Width of tape on fittings shall not exceed 2". Tape shall adhere tightly to all surfaces of the fittings, without air pockets.

Cleaning: Clean all piping thoroughly before wrapping.

Inspection: Damaged or defective wraps shall be backfilled against the wrap. Protect wrap with an outer wrapping of Kraft paper; leave in place during backfill.

Access Doors: Milcor, Newman, or equal, with concealed hinges, screw-driver locks, prime coated with rust inhibitive paint, and style of door to suit ceiling or wall construction. Access doors in acoustical tile ceilings shall have tile recess. Doors shall be 14 gauge C.R. steel and shall be 18" x 12" unless otherwise noted or required.

Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

Thermometers:

Red reading mercury column type accurate within plus or minus one of smallest scale division throughout entire range, maximum 20° between graduations, located to be easily read, and furnished in straight, angle or side angle types as required. Normal reading shall be at mid-scale.

For piping, a minimum scale length of 9" with an extension for insulation.

For tanks, Weston 5" dial type with extension for insulation.

Provide thermometers with steel bulb chambers and brass separable sockets.

Thermometers for air temperature shall have a minimum scale length of 9", adjustable mounting flange so that scale may be set at any angle up to 45°, perforated guard over stem suitable for sensing air temperature, 8" minimum stem.

Place at all locations shown or scheduled on the drawings and adjacent to each remote bulb thermostat.

Provide thermometer test wells on inlet and outlet of each coil and chiller.

Flexible Connections: Furnish and install flexible couplings on piping systems as shown on the drawings. All components shall be suitable for pressure and type of service.

Anti-Vibration Bases and Hangers: Isolate all connections to operating equipment including conduit, piping, drains, etc., so that equipment vibration will not be transmitted to the structure.

Equipment bases shall be as shown on the drawings.

Springs used for vibration isolation shall be laterally stable, open coil springs shall have a ratio of loaded height to diameter not greater than 1.25. Springs shall have at least 50% reserve deflection beyond the design static deflection when fully loaded and shall remain within the elastic limit of the steel if fully compressed.

Resilient hangers shall remain effective with at least 15 degrees of misalignment.

Miscellaneous Frames and Covers: Furnish all steel channel frames and covers in connection with concrete work required by this section of the specification. All items shall be welded construction and, except as noted, hot dip galvanized after fabrication.

Gages: Marsh "Quality Gage," U.S. Gage, or equal, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2" dial face. Normal reading shall be at mid-scale. Provide a gage cock on each gage connection.

Supply gages on inlet and outlet of each pump and where shown on the drawings.

Strainers: Charles M. Bailey #100A, Armstrong, or Muesco Fib. 11 "Y" pattern, 125 psi W.P. minimum, with monel screens with 20 square mesh or 3/64" perforations. Install all strainers with a blow-off hose valve with hose adapter. Strainer shall have gasketed cover with straight thread.

Concrete Work: Concrete work required for work of this section shall be included under another section of the specifications, unless otherwise noted. This shall include all poured in place concrete work for installing precast manholes, catch basins, etc., and shall include reinforced concrete bases for pumps, tanks, compressors, fan units, boilers, unless the work is specifically indicated on the drawings to be furnished under this section.

Thrust blocks, underground anchors, and pads for cleanouts, valve access boxes and washer boxes are included under this Section of the Specifications.

Pumps

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General: Provide floor mounted pumps with a 6" high concrete base and anchor bolts as recommended by the pump manufacturer. Pumps shall be carefully shimmed level.

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Do not connect to piping before piping is thoroughly flushed and clean.

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Domestic hot water pumps shall be all bronze.

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Support piping from the building structure to prevent any strain on the pump casings. Check alignment of the piping connections and motor coupling after pump has been secured to its base.

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Pumps shall be of the centrifugal type with non-overloading characteristics and shall not overload the motor above its nameplate horsepower rating (no service factor will be allowed) under any operating conditions. Motor horsepower shown is minimum, furnish larger motors if necessary to meet the non-overloading requirements.

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Increase piping immediately at pump suction and discharge, flexible couplings and all valves shall be full line size.

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Pump impeller shall be trimmed, without cost to Owner, to obtain the desired water flow after installation.

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Motor housing shall be cast iron with factory installed junction box and shall be NEMA labeled. Motors exposed to the weather shall be NEMA IIIIR.

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Close Coupled Pumps: Shall have cast iron casing, bronze enclosed impeller, bronze casing wearing rings and slinger ring. Motor and pump housing shall have tongue and groove construction keyed to bracket for alignment. Pump impeller and motor armature shall be mounted on a common shaft which shall be one piece of stainless steel. The impeller shall be keyed to the shaft and locked with a lock nut.

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All rotating parts shall be statically and dynamically balanced. Provide with mechanical seals as recommended by the manufacturer for the temperature and fluid being handled.

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Provide flanged connections on all pumps above 2" discharge size, pump connections shall be full size of specified pumps.

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Flexible Coupled Pumps:

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Shall meet all applicable requirements of close coupled pumps.

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Shall have well ventilated bearing housing.

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Flexible coupling shall have a guard to comply with the California State Industrial Accident Code.

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Pipe Supported Pumps:

Shall have cast iron case, bronze impeller, mechanical seal, flexible coupling, and flanged connections.

Single phase motors shall have built-in thermal overload protection or a separate thermal switch.

Pump connections shall be full size of specified pumps.

Split Case Pumps

Pumps shall have a cast iron casing with smooth passageways, capable of withstanding a hydrostatic test pressure 150% of the maximum pumping pressure under which the pump could operate at design speed. Suction and discharge connections shall allow removal of the rotating element without disturbing the piping connections. Provide bronze casing wearing rings locked to the casing to prevent movement.

The impeller shall be made of cast bronze, accurately keyed to the shaft and secured with a lock nut. The shaft shall be 416 stainless steel.

Pumps shall have ball bearings, grease lubricated, mounted in housings, with a grease fitting on the bearing housing. Bearing housings shall be duct tight with water deflectors or seals to prevent water from entering the bearing housing.

Unless noted otherwise, pumps shall have mechanical seals suitable for the temperature and fluid handled.

A flexible coupling shall be provided with a coupling guard to comply with the California State Industrial Accident Code.

All rotating parts of the pumps shall be statically and dynamically balanced.

Provide drain connections at all points where drainage can occur. The pump casing shall be well ventilated.

Insulation Work:

General: The term "Piping" used herein, shall include pipe, air separators, valves, strainers, and fittings. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering, cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible. Valve and fitting covers may be fabricated from the molded pipe covering.

Do not insulate flanges and unions on high temperature piping. Insulate unions and pump bodies on chilled water lines with three heavy layers of Mortell's No-Drip paint, 1/16" minimum total thickness.

Clean thoroughly, test, and have approved, all piping and equipment before installing covering.

Taper the insulation 45° to the pipe and seal the end of the insulation with the jacket. On insulation with vapor barrier jacket, provide a seal at maximum of 20'-0" on continuous pipe.

Insulation of Piping: Insulate all heating and domestic hot water supply and return, low pressure steam supply, steam vent, boiler feedwater, and low and high pressure steam return including pumped return piping with 1" thick, 3-1/2# per cubic foot minimum density fiberglass with standard factory attached fire retardant jacket, 1-1/2" thick for pipes over 6". Finish entire surface of jacket with one brush coat of diluted adhesive. Lap jacket seam 1-1/2" minimum. High pressure steam (above 15 psi) piping shall be insulated same as above, except 1-1/2" thick for pipes through 3-1/2"; 2" thick for 4" and above.

Insulate domestic cold water piping in the central plant room in the kitchen and in the ceiling space above the kitchen with three heavy layers of Mortell's No-Drip paint, 1/16" minimum total thickness.

All domestic hot water piping, including fittings and valves, exposed in public toilets shall be insulated with 1/2" nominal thickness Armstrong Armaflex.

Insulate all refrigerant suction piping, chilled water supply and return piping with 1" thick, 3-1/2# per cubic foot minimum density fiberglass, with factory applied fire retardant, vapor barrier jacket, 1-1/2" thick for pipes over 6". Cover the insulation on fittings with 2 layers of Glasfab saturated in Fosters 30-36, MMM, or equal, carried 3" over the adjoining pipe insulation. Finish with a coating of Fosters 30-36, MMM, or equal. A flap of the integral vapor barrier jacket shall be sealed with vapor barrier adhesive and the insulation shall be additionally secured with metal bands. The 4" wide end laps furnished with the insulation shall be adhered over the end joints and further secured with bands.

Urethane insulation will not be allowed. In lieu of the above, piping, except steam, including all fittings may be, at the option of the Contractor, insulated with nominal 3/4" thick Armstrong 620 adhesive, Owens-Corning, or equal. Apply insulation in strict accordance with manufacturer's recommendations.

Insulation of Equipment: Cover the condensate receiver and all uninsulated equipment containing steam or steam condensate with 1-1/2" thick 85% Kaylo blocks securely wired on with copper clad wire. Apply a 1-1/2" galvanized hexagonal mesh netting, stretched tight, and securely fastened to the insulation; over this apply two coats of hard finish asbestos cement to a total minimum thickness of 1/2". The first coat shall be left with a rough surface and allowed to dry before the second coat is applied. The second coat shall be trowelled smooth, and finished with 8 oz. canvas jacket, tightly pasted on with lagging adhesive. The entire surface of the canvas jacket shall have a finish sizing consisting of one brush coat of dilute adhesive. Manholes and handholes shall be made accessible by beveling off the insulation around the manhole. Boiler breeching shall be insulated same as above, except 2" thick and with 3/4" deep minimum V-rib wire lath securely wired in place

before applying the Kaylo.

Duct Insulation: Install acoustical lining in all supply, return or mixed air ducts and plenums. Lining shall be treated to prevent erosion and shall be equal to Johns Manville "Microbar," Owens Corning "Mat-faced Ductliner," Gusten Bacon "Utralite" 200 with the following minimum absorption coefficients:

Frequency (cps)	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>
Minimum Absorption Coefficient	0.20	0.52	0.64	0.87	0.87	0.80

*Values based on a one-inch thickness, tested in accordance with AMIA standards, Mounting #6.

Line exhaust ducts for a minimum of 10'-0" from fan inlet, and 10'-0" downstream from each register or grille. Line all transfer ducts. Lining shall be 1" thick except for exhaust ducts, 1/2" thick. Cement the lining in place with 100% coverage of Fosters #81-99 or 85-10 Saftee Duct-Fas, 3M #38, or equal, and coat all edges and joints. In addition, on top and sides of ducts over 20" in either dimension fasten with stick-lips cemented with Minnesota Mining Co's No. EC-896, Fosters, or equal, spaced at 18" maximum centers both ways. Lining thickness shown on the drawings shall take precedence over the specifications. Seal airtight transverse seams of all supply, return and exhaust ducts, except those exposed in the conditioned space, with 6 oz. canvas dipped in Arabol, MMM, or equal.

Seal watertight all joints of all ductwork exposed to the weather with 6 oz. canvas dipped in Arabol, MMM, or equal, cover the canvas with a heavy clat of Fosters #30-76 or equal, no dilution.

All seam fillers and adhesives shall be incombustible when liquid or dry.

Equipment Identification: Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2" high white letters on black background, for example, EXHAUST FAN 2.

Pipe Identification: Identify each piping system and indicate the direction of flow by means of Idento Bands (Idento Metal Products Co.) or printed labels on pressure sensitive self-adhesive cloth tape, General Painting Co., Westline Products, or W.H. Brady Co. Apply the markings after all painting and cleaning of the piping and insulation is completed. Seal tape with clear lacquer after installation.

Apply the legend and flow arrow at all valve locations, at all points where the piping enters or leaves a wall, partition, cluster of piping, or similar obstruction, and at approximately 50'-0" intervals on pipe runs; variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each

room. Markings shall be located for maximum visibility from expected personnel approach.

Wherever two or more pipes run parallel, the markings shall be applied in the same relative location on each.

The legends and flow arrows shall be black on background colors as recommended by ASTM or ASA for material flowing.

The sizes of the lettering and flow arrows shall be as follows:

Outside Diameter of Pipe or Covering (Inclusive)	Size of Letter	Minimum Length of Flow Arrow
5/8" to 2"	1/2"	2-1/2"
2-1/2" & larger	1"	4"

Each hand valve on non-potable water piping shall be labeled with a metal tag stamped "DANGER -- NON-POTABLE WATER" in one-quarter inch (1/4") high letters.

Guards:

General: Belt drives, gear drives, shafts, couplings, fan inlets and outlets and running equipment shall be properly protected by guards as required by the California Administrative Code, Title 8, Division of Industrial Safety, Sub-Chapter 7, General Industry Safety Orders, Articles 31 through 36, whether shown on the drawings or not.

Construction: Guards shall be factory furnished or made of expanded metal with angle iron framework. Guards for belt drives shall have an easily removable section for replacement of belts. Openings shall be provided at shaft ends for taking Rpm readings.

INSTALLATION

Piping Systems:

General: Should structural difficulties or other work such as ducts, conduits, lights, etc., prevent the running of pipes or the setting of equipment at the points indicated by drawings, changes as authorized by the Architect shall be made without additional cost to the Owner. All piping shall be concealed unless shown or directed otherwise. Run exposed piping parallel to building surfaces with minimum fittings and support to prevent movement.

Grade all water circulating piping, flow and return, to provide for drainage of lines and elimination of air.

Close ends of pipe immediately after installation, leave closure in place until removal is necessary for completion of installation.

Each piping system shall be thoroughly flushed and proved clean before connection to equipment.

Pipe the discharge of each relief valve, air vent, backflow preventer and similar device to floor sink or drain.

Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.

Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.

Water lines in same trench with sewer lines shall be on a solid shelf at one side of the trench, 12" minimum above top of sewer pipe.

Anchor: Piping subject to expansion or contraction shall be provided with anchors and expansion loops or joints as required. Provide adequate guides to prevent misalignment. Isolate pipe from anchor with neoprene.

Sleeves: Install AMI sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. Sleeves through the floor in Mechanical Equipment Rooms shall extend one inch above the floor, the space between pipe and sleeve and between sleeve and floor shall be sealed watertight. At contractor's option Link Seal casing seals may be used in lieu of caulking.

Floor, Wall and Ceiling Plates: Fit all pipes with or without insulation passing through floors, walls, or ceilings, and all hanger rods penetrating finished ceilings with chrome plated or stainless steel plates. Openings through air plenums shall be sealed airtight.

Fireproofing: The annular space between the pipe sleeves and the pipe and between duct openings and ducts through all floors and walls shall be packed with an incombustible material, Fiberglas or equal, and sealed at the ends with mastic, or other suitable material.

Valves: Supply piping systems with valves arranged to give complete and regulating control throughout buildings. Install valves so all parts are easily accessible and maintained. Install globe valves in horizontal lines with stems horizontal and to close against pressure.

Hangers and Supports:

General: Support all piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required. Rigidly fasten hose faucets, fixture stops, and similar items at ends of pipe branches to the building construction. All hanger material shall be approved by the Architect before installation. Support no piping by any plumber's tape, wire, rope, wood, or other makeshift devices. Piping shall be isolated

from the building structure as shown on the drawings.

All hanger components shall be Kin-Line, Grinnell, Super-Strut, or equal. Unless noted on the drawings, hangers shall be as follows:

Vertical Piping: Grinnell #261 clamps attached to the pipe above each floor, provide with lead or Teflon liners on copper tubing. Provide additional support at base of cast iron risers.

Individually Suspended Piping: Kin-Line 440, 440 F with threaded rod. Provide E-Z Isoliner neoprene isolator for all uninsulated piping. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

<u>Pipe Size</u>	<u>Rod Size</u>
2" and smaller	3/8"
2 - 1/2" to 5"	1/2"
6" to 8"	5/8"

Trapeze Suspension: Kin-Line channel in accordance with manufacturer's published load ratings. No deflection to exceed 1/180 of a span.

Trapeze Supporting Rods: Shall have a safety factor of 5, securely anchor to building structure.

Pipe Straps: Kin-Line 412 with 418 neoprene isolators for copper tubing.

Concrete Inserts: Super-Strut C-302 continuous insert or C-452 spot insert. Insert nuts AC-100.

Pipe Support and Hanger Spacing Schedule:

<u>Type of Pipe</u>	<u>1" Diameter or Under</u>	<u>1-1/4" to 3" Dia.</u>	<u>3 - 1/2" Diam. and over</u>
Steel Pipe	8'-0"	10'-0"	12'-0"
Copper Tubing	5'-0"	8'-0"	10'-0"
Gas Piping	6'-0"	6'-0"	6'-0"
Cast Iron	Support at every joint and 19'-0" maximum.		

Suspend rods from concrete inserts with removable nut where suspended from concrete decks.

On insulated pipes install the hangers on the outside of the pipe covering and not in contact with the pipe. An 18 gauge galvanized sheet iron shield, minimum length 8", shall be installed between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.

Burning or welding on any structural member may only be done if approved by the Architect.

No valve or piece of equipment shall be used to support the weight of any pipe.

Provide a support or hanger close to each change of direction of pipe either horizontal or vertical.

Service Markers: Mark the location of each plugged or capped pipe with a 4" round by 24" long concrete marker, Haley Mfg. Co., Lodi, or equal, set flush with finish grade with engraved brass plate identifying stub.

SUBMITTALS

Maintenance and Operating Instructions: Furnish two complete sets of operating and maintenance instructions bound in a hardboard binder and indexed. Start compiling the data upon approval of list of materials. Final inspection will not be made until booklets are approved by Architect.

These sets shall incorporate the following:

Complete operating instructions for each item of heating, ventilating, air conditioning and plumbing equipment.

Test data and air balancing reports as specified.

Typewritten maintenance instructions for each item of equipment listing in detail the lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.

Manufacturer's bulletins with parts numbers, instructions, etc., for each item of equipment, properly stripped and assembled.

Temperature control diagrams and literature.

A complete list or schedule of all major valves giving the number of the valve, location and the rooms or area controlled by the valve. Permanently tag each valve with number to match schedule.

Post service telephone numbers and/or addresses in an appropriate place as designated by the Architect.

As-Built Drawings: The Contractor will be furnished with two (2) sets of white prints pertaining to mechanical work showing all items of work furnished by this Contractor on which he shall indicate the locations of all installations as the work progresses. These shall be returned to the Architect when completed so that he can record the data.

Shop Drawings: Unless specified elsewhere, submit 7 copies of shop drawings, equipment lists, or other submittals for approval prior to execution of work.

SECTION 15B - HEATING, VENTILATING & AIR CONDITIONING

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RELATED DOCUMENTS

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The general provisions of the contract, including General Conditions and Special Conditions, apply to the work specified in this section.

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Applicable provisions of Section 15A - Mechanical Work - General Requirements, also apply.

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DESCRIPTION OF WORK

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Furnish and install all heating, ventilating, and air conditioning work indicated on the drawings and described herein. Also any incidental work not shown or specified that is necessary to provide the complete systems.

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GENERAL

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Guarantee and Service: Provide any service incidental to the proper performance of the temperature control system according to the provisions of Section 15A.

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Coordinated Layouts: Prepare and submit to the Architect, upon request, large scale coordinated composite layouts showing on both plan and elevation all ducts, piping and conduits in congested areas such as fan rooms, ceilings, shafts, and equipment rooms. Show all mechanical and electrical services on each composite drawing. Check routing of all ductwork on the job before fabricating. Report any discrepancies to Architect. No extra cost will be allowed for failure to conform to the above.

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It shall be the responsibility of the Heating, Ventilating and Air Conditioning Contractor to coordinate the other mechanical and electrical trades so that the complete job is neat and in conformity with plans and specifications.

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MATERIALS

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Pipe and Fittings: See General Requirements Section for dielectric fittings and pipe protection.

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Hot water and chilled water piping: Schedule 40 black steel pipe, ASTM A-120. Fittings shall be Nibco standard butt welding type conforming to A.S.A. Specification B16.28 latest standards; except that fittings 2" and smaller and local exposed connections to equipment may be 150 psi malleable screwed fittings.

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Air vent discharge piping: Type L hard copper tubing with wrought copper fittings.

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Water, drain, or gas connections to equipment shall match connected piping.

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Condenser water piping shall be Schedule 40 galvanized steel pipe with threaded 150 pound galvanized iron or black cast iron fittings or Victaulic fittings.

Condensate drain piping: Type DWV copper tubing and fittings or Schedule 40 galvanized steel pipe and galvanized malleable fittings.

Steam piping, including condensate return, pumped return and steam vent: Schedule 40 black steel pipe with welding fittings, Tube Forgings, conforming to A.S.A. Specification B16.9, latest standard. All changes in size shall be made with eccentric fittings.

Expansion Joints: Furnish and install expansion loops or joints in the steam or water lines as shown or required with anchors and guides as shown or required for the proper operation of the expansion loops or joints.

Fans: All fans shall be AMCA labeled.

Bearings shall be self-aligning, enclosed, ball or roller bearings, accessible for lubrication, unless specified otherwise.

All fans exposed to the weather shall be provided with weep holes at the bottom of the casing and Heresite VR 500 coating on wheel and inside and outside of scroll.

Each ceiling or wall mounted fan shall have a multi-speed switch and integral backdraft damper.

Provide access doors for fans or motors mounted in ductwork.

Provide bird guard and prewired disconnect switch on each roof mounted fan.

Mount all fans so that they are completely isolated from the building.

Roof fans shall be prime coated.

Fan motors mounted in the air-stream shall be totally enclosed.

Supply, return or exhaust fan cabinets shall be completely lined with 1/2" thick, 1-1/2 lbs. density acoustic insulation securely cemented in place with all joints and surfaces treated to prevent erosion.

Fan Drives: All supply, return and exhaust fan drives shall be Dayco, Browning, or equal, drives for A or B belts with a rating of 1.5 times motor horsepower.

Minimum pitch diameter of driver sheave shall be 3" for "A" belts and 5" for "B" belts.

Motors of twenty-five horsepower and less shall have adjustable pitch sheaves, with the midpoint of the adjustment range equal to the RPM requirement of fan, this shall include propeller fans with belt drives.

Motors larger than twenty-five horsepower shall have non-adjustable sheaves.

Change, at no extra cost to Owner, the size of the non-adjustable sheaves to obtain the desired air quantities.

Submit for approval complete data on drives proposed, along with fan data, showing section, length, and number of belts, pitch diameter of driven sheave, and maximum and minimum pitch diameter of adjustable or driver sheave.

Filter Gages: Furnish and install for each bank of air filters a F.W. Dwyer No.25 U.S. gage.

Filters: Filters shall be as shown on the drawings.

Mount filters in air tight frames furnished by the filter manufacturer, installed in accordance with manufacturer's recommendations.

Provide temporary filters for all fans that are operated during construction; after all construction dirt has been removed from the building install new filters at no additional cost to the Owner. This requires two sets of filters.

Sheet Metal Work: Construct and install all sheet metal in accordance with latest ASHRAE and SMACNA recommendations. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances, as approved by the Architect, at no extra cost to the Owner. Ductwork shall be made of commercial grade of galvanized iron.

Provide drive slip or equivalent flat seams for ducts where necessary due to space limitations. On ducts over 18" wide, install tie rods or 1" x 18 gage vertical, internal braces at 34" centers longitudinally and 20" center laterally.

Ductwork exposed in conditioned space shall have all joints and reinforcing on the inside of the duct within the thickness of the lining. Exterior shall present a neat, finished appearance. Runouts to grilles, registers, or diffusers on exposed ductwork shall be the same size as the outer perimeter of the flange on the grille, register or diffuser.

The throat radius of all bends shall be 1-1/2 times the width of the duct wherever possible and in no case shall the throat radius be less than one width of the branch duct. Provide square elbows with Titus or HEP double thickness turning vanes where space does not permit the above radius, or where square elbows are shown.

The slopes of transitions shall be approximately one to five and no abrupt changes or offsets of any kind in the duct system shall be permitted.

Provide Ventfab flexible connections on inlet and outlet of each fan, Ventglas if exposed to weather.

Round ducts with equivalent effective cross sectional areas as determined by ASHRAE Guide, latest edition, may be used in lieu of concealed rectangular ducts shown, space permitting.

Seal all seams around fan and coil housings airtight with white "Hydro-seal" Fosters caulking compound.

Duct size shown on lined duct is the outside dimension.

Provide Ventlok access doors with series 100 hardware for convenient access to all automatic dampers and other components of the system. Provide Ventlok #310 latches and #260 hinges on all personnel access doors.

Provide Ventlok #699 test hole fittings where indicated.

Paint inside of ducts, visible through grille, dull black.

Fiberglas ductwork will not be allowed.

Kitchen hood exhaust ducts shall have clean-out access doors spaced 10'-0" maximum. They shall meet City of Sacramento standards and shall be watertight and arranged for easy cleaning and draining.

Ducts shall clear combustibile construction by 1/2" minimum.

Ceiling Plenum Barrier: St. Regis Sisalkraft Pyro-Kure 615 Koppers, or equal, sheet fastened to the ceiling and overhead construction to form an airtight assembly. Adhesive shall be Benjamin Foster 8520. All materials shall be non-combustible.

Underground Ducts: Cement asbestos air duct, with standard fittings and neoprene sleeve couplings with stainless steel straps.

In lieu of the asbestos-cement fittings, contractor may install 22 gage sheet metal fitting completely encased in concrete, 6" minimum thickness all around the duct.

Bed the entire underground duct system in 4" deep sand with a layer of 6 mil viscosine completely enveloping the duct, backfill the trench with sand. Wrap Viscosine around metal fittings before pouring concrete. Tape Viscosine joints with longitudinal seam on top of pipe. Entire installation shall be watertight.

Dampers: All dampers automatically controlled by damper motors are specified under "Temperature Control System" except those specified with items of equipment.

Provide opposed blade manual dampers at each branch duct connection and at locations indicated on the drawings and where necessary to control air flow for balancing system. Provide Ventlok Duro-dyne or equal, regulators. Provide an opposed blade balancing damper in each zone supply duct. Damper blades shall be 16 gage minimum galvanized steel with 3/8" minimum shaft, 10" maximum blade width.

Provide an access panel or Ventlok flush type damper regulator on ceiling or wall for each concealed damper.

Install fusible link fire dampers full size of duct at points where shown or required. Fire dampers shall be furnished with fusible links and chains and shall meet all requirements of the National Board of Fire Underwriters; this shall include the 10 gage steel plate sleeve, where required, at fire walls. Provide one fusible link for each 6 square feet of damper or fraction thereof.

Provide 18" x 12" minimum access doors in ductwork and furring for easy access to each fire damper.

Grilles and Diffusers: Provide all outlets with gaskets and metal grounds and install so that there will be no streaking of the walls or ceilings due to leakage. Standard grille frames may be used in lieu of metal grounds. Submit details of metal grounds for approval. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.

Furnish all diffusers, registers, and grilles with off white baked enamel finish or black anodized aluminum as indicated on the drawings.

Grilles and diffusers shall match all qualities of those specified, including appearance, throw, noise level, adjustability, etc.

Provide each extractor damper 24" or more in length with a roller bearing support at free end; submit detail.

Anti-Vibration Bases and Hangers: Refer to Section 15A and the drawings for vibration control.

Air Conditioning Units: Fans shall be equivalent to Class I, including wheel, shaft, bearings, and scroll rated to 3-1/2" static pressure. Provide stabilizing damper on fan outlet.

Coils shall have 5/8" diameter copper tubes with aluminum fins. Tubes shall be a minimum of 0.025" wall thickness. Fin spacing shall be equivalent to 8 fins per inch. Casing shall be galvanized.

Insulation of 1-1/2 lbs. per cubic foot density shall be 1" minimum thickness throughout the cabinet, including the fan section, having

both thermal and acoustical qualities. Insulation shall be securely cemented to the panels with all joints and surfaces treated to prevent erosion. Drain pan shall also be insulated.

Drain pan shall be galvanized and internally treated with a heavy layer of mastic. It shall extend under the cooling coil, including coil connections and any module extending beyond the cooling coil.

Provide access panels or hinged access doors for convenient filter removal and for convenient access to all components and compartments and as shown.

Fan motor shall be 1750 RPM maximum, V belt drives as specified herein. Fan motor shall be mounted on an adjustable motor mount furnished by the manufacturer. Drive guard shall comply with California Division of Industrial Safety.

Seal all joints between sections with mastic and made airtight.

Extend lubrication fittings to a point easily accessible and visible.

Discharge mixing dampers on multi-zone units shall have rubber edged blades including blade ends, damper frames shall be sealed airtight to duct. Dampers shall be Pneumaseal #OB-1001 as manufactured by Pacific Air Products.

Package Multi-Zone Air Conditioning Unit: Air conditioning unit shall be self-contained of the size and capacity as scheduled on the drawings. Each unit shall include insulated casing; single hermetic compressor with internal unloaders, cylinder liners, spring loaded discharge valves; condensers; coils; fans and drain pan. Filters shall be as previously specified. Each refrigerant circuit shall include preset thermal expansion valve, filter-drier, fusible plug, liquid line shut-off valve, dual pressure controls, crankcase heaters and sight glass. Provide a separate refrigerant circuit for each compressor. Provide a heating coil as scheduled. Unit shall include time delay relay or similar means of preventing short cycling.

Units shall operate without undue noise or vibration. Compressor, fan and motor shall be isolated from the cabinet with vibration mounts. Complete details of assembly shall be submitted for approval prior to manufacture.

All wiring within the units shall be provided by the unit manufacturer and shall conform to the requirements of the National Board of Fire Underwriters.

Furnish and install a complete charge of refrigerant and lubrication for the system. Replenish all refrigerant and oil lost for a period of one year without charge to the Owner.

Package Air Conditioning Unit: Shall be completely self-contained type including compressor, fans, filters, starters, and automatic controls

Motor starter shall be installed under the centrifugal compressor manufacturer's recommendation to provide completely automatic operation of the centrifugal refrigeration system with 30 minute time delay between stopping and restarting.

Refrigerant and Oil: Furnish a complete charge of refrigerant and oil, this charge guaranteed for one year's operation. Furnish any amount required during this period at no extra cost to Owner.

Insulation: Refer to Insulation Work, General Requirements section. Insulation shall be applied to areas designated by manufacturer. Any surfaces showing evidence of sweating after the chiller is in service shall be insulated.

Installation: Furnish the service of a factory representative for a period of fifteen working days to advise on the following:

Test the refrigeration system under pressure for leaks; evacuate and dehydrate the system by the use of a high vacuum pump.

Charge the system and instruct the operator of the machine on proper care and operation.

Electric Heaters: Duct elements installed in the ducts where shown, complete with remote contactors, all U.L. labeled. Contactors shall be readily accessible within 6'3" of floor.

Heaters shall be interlocked to operate only when supply fan is on. Heaters shall have capacity as noted on the drawings. Multi-circuits shall be provided where scheduled. Thermal cut-out shall be built into each heater.

Baseboard heaters shall be complete with thermostat section for each room and as shown, end sections for finished installation, shall be U.L. labeled.

Hot Water Boiler:

(See Alternates) Furnish and install water tube boiler with a capacity as noted on drawings. Boiler shall be manufactured in strict accordance with the ASME Boiler Code, 125 psi operating pressure. Boiler shall be constructed of welded steel boiler plate, with adequately sized water legs and tube headers, providing proper internal water circulation. Water tubes shall be 12 gage steel and 1-1/2" diameter minimum and shall be easily replaceable. Boiler shall have a minimum of 5.0 square feet of surface per boiler horsepower.

Boiler shell shall be furnished with an adequate number of tappings and inspection openings to facilitate boiler inspection and cleaning. The entire tube area shall be easily accessible for cleaning through cleanout openings. Access openings are to be arranged for visual access to combustion chamber and burner.

Boiler shall be of the bent tube design complete with an insulated metal jacket, consisting of not less than 2-1/2" thick minimum Fiberglas

insulation and a 16 gage rust resistant alloy steel casing painted with a suitable heat resisting primer and lacquer. The combustion chamber shall be lined with 2-1/2" high temperature insulation board or refractory. Complete jacket and insulation shall be readily removable and reinstalled if necessary.

Boiler shall be furnished with the trim and controls herein specified.

Gas and oil burner unit shall be U.L. labeled, forced draft, pressure atomizing type for natural gas and #2 fuel oil.

Boiler Controls: (See Alternates) The following controls shall be installed on each boiler as a minimum:

Water Relief Valves: Shall be of the dual set, spring-loaded type without disc guides in the pressure side. The ASME rated output of the relief valve shall be not less than 80% of the boiler input rating. Pipe each individual discharge to floor sink from each discharge opening.

Water Feeder: Shall be McDonnell and Miller 53-2 watts or equal, with auxiliary low water cutoff.

Firing Controls: Modulating type for both fuels with low fire start.

Alarm Bell: With silencer switch to sound on flame failure, low water and high temperature, with indicating lights and relays for remote annunciation of these failures.

Low Water Control: M&M #157M M-H, or eq., manual reset. Unit shall mounted by boiler manufacturer at lowest permissible water level. Fit the low-water control with a 1" valved drain to permit periodic manual checking.

Temperature Controller: Shall be an adjustable operating temperature control, to maintain the operating temperature at the predetermined setting.

High Limit Control: Shall be MH #L4006E Mercoid or eq., to shut off fuel to the burner when the temperature in the boiler reaches a predetermined maximum, not to exceed 200° F. The fuel control valve or the high-limit control shall require manual resetting when it operates due to high temperature condition.

Auxiliary Gas Valve: General Controls K3 M-H or eq., piped in series with and wired to operate in unison with the normally furnished automatic fuel valve.

Ultraviolet Flame Scanner: Ignition assembly for both fuels with program type combustion control providing pre post purge.

Water Pressure Gage and Thermometer: Shall be provided at or near the boiler outlet and to indicate pressure and temperature conditions. They shall be readily visible from the operating level. Provide a tee on pressure tapping with a cock for test gage. Thermometer shall be in a separable well.

Controls: Shall be set and adjusted by an authorized representative of the boiler manufacturer or burner control manufacturer and a complete control diagram of permanent, legible type, together with an operating manual giving complete boiler operating instructions shall be provided prior to operating the boiler plant.

Cold Water Make-Up Set: Provide for each boiler and chiller a cold water make-up set including Gate valve, check valves, union, pressure type vacuum breaker, Mueller #H-9001 watts or eq., regulator with strainer. Provide a Mueller #H-9047 watts, or eq., relief valve on chilled water system. Make-up set size shall be as indicated on the drawings.

Breechings and Flues: Main boiler stack shall be a prefabricated sectional type listed by Underwriters' Laboratories, Inc., as manufactured by the Van Packer Co. Division of the Flintkote Company, Model H.T.

Each stack section shall consist of an insulating refractory wall encased in a corrosion-resistant metal jacket. Insulating refractory shall be centrifugally spun into the metal jacket. Slumped or poured mix is not acceptable.

Assembly shall be made by joining stack sections with silicone joint cement and covering joint with corrosion-resistant metal drawband. All above material shall be supplied by the stack manufacturer. Total height shall be as shown on drawings, with lateral and/or vertical support as recommended by the stack manufacturer. Installation shall be made in accordance with specifications of Underwriters' Laboratories, Inc., and the manufacturer.

Stack for steam boilers and domestic water heating boiler shall be Dura-Vent or Metalbestos flue complete. All joints shall be gas-tight. Provide weather-proof flashing at roof. Terminate with Breidert Type L flue cap.

Breechings shall be #10 gage steel with all joints welded gas-tight. Insulate as previously specified.

Draft Inducer: (See Alternates.) Furnish and install as shown an induced draft fan complete with controls and all necessary appurtenances.

Expansion Tank:

Furnish and install as shown on drawings Ex-trol pressurized diaphragm type expansion tank complete with sightglass. It shall be factory pre-charged and shall be ASME stamped and certified 125# and to operate at 240°F. The above to be American Tube and Controls or C.R. Bernstrom or equal.

Fuel Oil System (See Alternates)Furnish and install outside below grade as shown on the drawings, Underwriters' label tank with complete accessories as specified or shown on the drawings. Tank shall be black steel, all welded construction.

Tank shall be shop painted on the outside with two coats of Farbertite Bitumastic, or eq., in strict compliance with mfg.'s recommendations.

Exercise care in placing tank to prevent damage to paint; repair all damage before tanks are covered. 5
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All openings in the tank shall be tank flanges bent to contour of tank and welded in place. Openings for water draw-off and foot valve extractor shall be double tapped bushings. 8
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Foot valve shall be "Circle Seal" type #P585, 3/4" size, as made by James, Pond and Clark Co., Pasadena, California, OPW, or equal. 12
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Fill box shall be Emco-Wheaton A-0571, OPW, or equal, 3" ironbody flush fill box. Cover shall have "Diesel Fuel" stamped in plate. 15
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Tank gage shall be Liquidometer Senior OPW, or equal, with dial graduated in gallons, complete with tank assembly, low level alarm contracts, and conduit. 18
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Cap on stick gage pipe in manhole shall be Emco-Wheaton A-0752, OPW, or equal. 22
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Vent pipe shall terminate in a Emco-Wheaton A-0785, OPW, or equal, vent protector, minimum 10'-0" above grade. 25
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Suction, return and water draw-off piping shall be Schedule 80 extra strong black steel and shall be made up with 300 psi malleable iron screwed fittings. 28
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Fill and vent piping shall be Schedule 40 black steel with malleable iron fittings except that portion of the vent pipe exposed above grade shall be galvanized. 32
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All piping shall slope uniformly back to tank, minimum slope 1/8" per 1'-0". All connections at tank shall be made with swing joints. All screw connections shall be made up with litharge and glycerine, except capped connections. All piping under ground shall be wrapped, see Section 15A. 36
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Fuel oil pump shall be as schedule on drawings. 42

Furnish 500 gallons of fuel oil for testing. 44

All Suction and Return Piping, before being connected to tank, shall be tested to a vacuum of twenty-eight inches (28") and shall maintain this vacuum for 12 hours. A minimum of 10 gallons of fuel oil shall be poured into the top of the vent pipe. After this has been allowed to drain, smoke shall be gently blown through the vent to prove the absence of any traps or restrictions. 46
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Tank shall be tested to five pounds (5#) air pressure before any piping is connected and shall hold this pressure for 12 hours without any drop in pressure showing on the gage. If tank shows any evidence of air leakage, it will be rejected and tank shall be made airtight at the above pressure before it will be accepted. 53
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On completion of all piping, the entire system shall be tested to five pounds (5#) pressure and shall hold this pressure for 12 hours without any evidence of leaks. The Engineer shall be notified 48 hours before the above tests are made. At completion, the Contractor for the diesel oil storage system shall furnish a written guaranty that the entire system will operate free from defects and that he will replace or repair to the satisfaction of the Engineer, and without cost to the Owner, any part or portion of the work that fails within a period of two (2) years after final acceptance, provided such failure is due to defects in materials and/or workmanship.

Domestic Hot Water Boiler & Tank: Bryan R.K. or eq. Indirect Water-Pak System factory assembled and wired with inter-connecting piping and controls. The only field connection requirements shall be the cold water inlet, hot water outlet, fuel, electrical and vent. The indirect water heater shall be manufactured and stamped in strict accordance with ASME Low Pressure Heating Boiler Code, Section IV. Heater water tubes shall be easily removable and replaceable without requiring welding or rolling.

The water heater shall be furnished complete with one or more indirect heat exchangers installed in the upper drum of boiler, heat exchangers capable of absorbing 100% of the total boiler output. Heat exchangers are to be constructed of heavy copper seamless tubing, attached to brass heads. Heat exchangers shall be attached to boiler shell by means of a gasket and stud type connection and shall be easily removable and replaceable.

The water heater is to be complete with an insulated metal jacket, consisting of not less than 1-1/2" fiberglass insulation and a 16 gage zinc-coated steel casing, painted with a suitable heat-resisting primer and lacquer. Complete jacket and insulation shall be readily removable and reinstalled if necessary. Combustion space shall be lined with insulating tile or board and no part of the jacket shall be exposed to the products of combustion.

The storage tank section shall be manufactured in strict accordance with the ASME Unfired Pressure Vessel Code Section VIII, for a maximum working pressure of 125 psi. Storage tank shall be lined with cement. All threaded connections shall be copper silicon. Storage tank shall be mounted in a vertical position. An 11" x 15" manhole shall be provided on tanks 42" diameter and larger.

Storage tank insulation shall be factory installed 1-1/2" fiberglass insulation with steel jacket.

An all-bronze circulating pump shall be installed to provide circulation between the storage tank and the water heater. All piping shall be copper and brass.

The water heater, the storage tank and all piping and accessories shall be mounted on a full-length structural steel channel base.

The water-pak system shall include the following fittings and trim:

Combination thermometer and pressure gage on heater. 5
Temperature gage on storage tank 6
ASME-rated hot water boiler relief valve on heater. 7
ASME-rated hot water pressure relief valve on heat exchanger. 8
ASME-rated hot water pressure relief valve for tank. 9
Adequately sized expansion tank. 10
Low water cutoff on heater. 11
Automatic heater fill valve. 12
Heater water temperature control. 13
Tank temperature control. 14
High Limit temperature control, manual reset. 15
Shutoff valves between heater and tank. 16
Heater and tank drain valves. 17

The gas burner unit shall be an integral part of the water heater, 19
tested, approved and listed by the American Gas Association. 20
Burner shall be for operation with natural draft, requiring no motor 21
or blower. Gas pilots are to be standing (continuously burning). 22
The burner is to be equipped with an automatic electrically operated 23
gas valve, gas pressure regulator and manual shutoff valve. A suitable 24
draft diverter shall be furnished. 25

Gas burner shall be hi-low-off, two-stage, with 100% shut-off 27
electronic pilot safety controls. An additional gas valve shall be 28
piped in series and wired in parallel with the normally furnished gas 29
valve. 30

The complete "Water-Pak" unit shall be factory assembled and furnished 32
by the Bryan Steam Corporation. The manufacturer's representative shall 33
be responsible for furnishing startup and instruction service on the 34
job. 35

Steam Boilers: Water tube boiler with an output capacity of 9-1/2 H.P. 37
based on minimum of 5 sq. ft. of heating surface per boiler horsepower. 38
Boiler shall be manufactured in strict accordance with A.S.M.E. stamp 39
of approval for a maximum working pressure of 100 psi. The boiler shall 40
meet all applicable requirements of State of California Boiler and 41
Fired Pressure Vessel Safety Orders and specifically Paragraph 771 (a) 42
(4). Boiler shell shall be constructed of welded steel boiler plate. 43
Boiler shell shall be constructed with adequately sized steam drums, 44
water legs and tube headers, providing proper steam release area and 45
internal water circulation. Water tubes are to be 1" O.D.-13 gage steel 46
minimum and shall be removable and replaceable without requiring welding 47
or rolling. 48

The boiler shell shall be furnished with an adequate number of tappings 50
and inspection openings to facilitate boiler inspection and cleaning. 51
The entire tube area shall be easily accessible for cleaning through 52
cleanout openings. Access openings are to be arranged for visual access 53
to combustion chamber and burner. 54

The boiler is to be complete with an insulated metal jacket consisting of 56
not less than 1-1/2" Fiberglass insulation and a 16 gage, rust resistant, 57

alloy steel casing painted with a suitable heat resisting primer and lacquer. Complete jacket and insulation shall be readily removable and reinstalled.

Gas burner unit to be an integral part of boiler. Burner shall be for operation with natural draft, requiring no motor or blower and shall be 80% efficient. Gas pilot to be standing (continuously burning). The burner is to be equipped with two automatic, electrically operated gas valves, gas pressure regulator and manual shut-off valve. One hundred percent pilot gas safety control shall shut down burner in case of pilot failure and shall be manually reset.

The following controls shall be furnished:

Pressuretrol for steam pressure control, set 50 psi.

Pressuretrol for high limit control, manual reset.

Boiler feed pump control and low water cutoff, column mounted with blowdown valve.

Secondary manual reset low water cutoff with alarm.

Two stage, high-low-off, low fire start, burner controls. Control panel containing necessary relays and on-off switch. Control voltage transformer (if required). The package boiler shall require only a single, 120 volt, electrical connection. Main disconnect switch by others.

Draft diverter, built in.

Boiler shall be furnished with following fittings and trim:

Steam pressure gage.

Water gage glass set with drain.

Try cocks.

ASME safety relief valve, 75 psi set.

Blowdown valve, slow opening, traveling stem, with bolted bonnet.

The boiler feed shall be through a solenoid valve. The solenoid valve shall be an Aktomatic Catalogue No. 15428GM, J-H, or equal, bronze, globe-type, with manual opening device and glass-silicone coil. Valve shall be wired and piped to a boiler with feed stop and check valve per ASME Code.

Boiler feed system for four boilers: A separately mounted duplex boiler feed system, Bryan Model BXB-82, P.K. or eq., including 60 gallon receiver with water make-up valve, gage glass and two boiler feed pumps, capacity 5 GPM at 75 psi; with 1 H.P., 3500 RPM, flexible

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Cooling Tower: Casing shall be heavy gage steel, hot dip galvanized after fabrication. Casing panels flanged outward on all four edges and corners welded. Panel fasteners located on exterior of tower. Sealer strip provided between all panel joints.	5 6 7 8
Steel basin of one-piece, welded construction with full-width depressed sump, basin fittings, including suction, overflow and drain welded into place.	10 11 12
Fill of galvanized steel retained in position between hot dip galvanized, heavy gage expanded metal panels located above and below the filling section.	14 15 16
Four-pass drift eliminators of galvanized steel located immediately above spray distribution system supported on hot dip galvanized expanded metal panel. Eliminators easily removed for access to distribution system.	18 19 20 21
Provide over-sized water header and branch arms of galvanized pipe, polyethylene nipples and non-clogging polyethylene spray nozzles. Nozzles placed on 6" centers to provide overlapping spray patten over entire fill area. Inlet header flanged at both ends. Full-length, two-piece, stainless steel, cylindrical perforated strainer located inside of header. Strainer easily removed from end of header opposite inlet riser connection.	23 24 25 26 27 28 29
Fans shall be statically and dynamically balanced centrifugal type. Blower wheels and scrolls hot dip galvanized after fabrication, self-aligning, grease lubricated ball bearings. V-belt fan drive.	31 32 33
Water Treatment: Provide a chemical feeder for each of the hot water and steam boilers, chilled water system, and each cooling tower.	35 36
The Contractor shall include in his work the services of a reliable water treatment company, Dearborn Aqua-Serv of California (Dale Van Riper, Sacramento), UOP Water Services (Ray Sterger, Galt), Skasol (Rolland Ray, San Francisco), who shall be notified when the job is ninety percent (90%) complete so that suitable water tests can be taken and a method of procedure prescribed for the proper treatment of the water in each system before the equipment is operated.	38 39 40 41 42 43 44
The water treatment company shall include in the quotation a minimum of six trips to the job during the period of one year that the guarantee exists in order to properly train maintenance personnel on the use of the chemical and to analyze any difficulty which may exist.	46 47 48 49
Provide a one year supply of treatment chemicals for each system.	51
The water treatment company shall notify the Owner regarding any deficiencies in the prescribed treatment.	53 54
The company selected to perform this service shall be acceptable to the Architect.	56 57

Material:

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Compressed Air Piping: (Other portions of specifications relating to copper piping shall not apply to control air piping.)

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Type L hard copper in furred ceilings and walls, Type L soft copper in ditches. Plastic tubing may be used behind panel boards or in protective gutter and for final connection to the various devices when accessible.

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Temperature control manufacturer shall size tubing to prevent excessive pressure drop. Install suitable drip legs and drains to prevent condensation pockets.

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Dissimilar metal fittings shall have dielect union separation. Fifty-fifty solder shall be used for the connection to the various devices.

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Tubing passing through footings, floor slabs or concrete walls shall be run through sleeves. Use Type L soft copper in masonry. Support tubing at 6'-0" maximum centers, run parallel to walls of building. All tubing mounted on duct work shall be bracketed off the duct, on insulated duct the bracket shall clear the insulation. No panels or controllers shall be subject to vibration.

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All branch and main air lines shall be blown clean to remove moisture and foreign material. All termination points shall be checked for air flow. Tubing shall be tested at 30 lbs. for a period of not less than four hours with 25 lb. residual at end of test. Soap test shall be used on tubing after system is in operation and minimum 15 lb. pressure and maximum 20 lb. pressure on instruments and lines.

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Air Compressor: Furnish and install air compressor and refrigerated moisture condenser of sufficient capacity to provide air for operating all controls with compressor operating one-third of the time, or as specified. Furnish permit by State Division of Industrial Safety prior to installation. Air compressor and all connections thereto shall be isolated from the building, mount on spring base.

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Dampers: Opposed blade type, black enamel finish or galvanized, nylon bearings, interlocking edges to prevent leakage, damper frame shall be sealed airtight to ductwork. Blades shall be 16 gage minimum, 10 inches maximum width and frame shall be of welded channel iron. Dampers with both dimensions under 18 inches may have strap iron frames. Dampers exposed to the weather shall be weatherproof, made of corrosion proof materials.

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Gages: Furnish and install a 2" diameter pressure gage on each connection to each instrument except in occupied space.

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SERVICE BID

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General:

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The Contractor shall include in his bid a price for the servicing of all of the installed mechanical equipment for a period of one year. The service shall be in conjunction with the terms of the guarantee and shall be performed on the following basis:

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The Service Contractor shall guarantee in writing that the response time for answering trouble calls shall not exceed four hours.

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A description of the servicing work shall be made on a prepared form signed by the Contractor and presented to the Owner's representative after each servicing.

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Maintenance Requirements: The following items are to be serviced on a thirty (30) day basis with the exception of the filters, which are to be serviced every sixty (60) days:

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23Hot Water and Steam Systems:

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Inspect, clean boiler inside and outside and adjust burners and pilots as required, check condition of flue.

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Check chemical feeder and condition of water.

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Check pump head and condition of pump and motor.

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Check automatic temperature controls and valve.

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Filters: Change media every sixty (60) days or as required by static pressure gage.

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37Air Conditioning Equipment (Fans, etc.):

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Lubricate all bearings and moving parts.

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Inspect, adjust and tighten all drive belts and replace as required.

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Clean fresh air intake and exhaust air outlets screen as required.

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Check and adjust dampers for correct air distribution and mixture.

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Clean strainers.

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Controls:

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Check Operation:

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Burner Controls

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Temperature Controls

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Dampers

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Chiller Unit Controls

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<u>Motors:</u>	5
Clean, oil and/or grease.	7
Remove waste and spilled oil or grease.	9
Check for overload under full operation.	11
<u>Chilled Water System:</u>	13
Maintain lubricant level at all times.	15
Check and adjust cut-in and cut-out switches and oil cut-out switches.	17
Check for correct charge of refrigerant and replenish as required.	20
Check and adjust thermostatic expansion valves.	22
Check and adjust head pressure control valve.	24
Check head and suction pressures and chilled and condenser water temperatures for indication of fouled heat exchange surfaces.	26
Check chemical condition of chilled and condenser water and check chemical feeders.	29
Check pump heads and condition of pumps and valves.	31
<u>Miscellaneous:</u>	33
Touch up paint as required.	36
Supply emergency service between regular inspections.	38
Contractor to maintain equipment and Equipment Room in a clean and orderly manner.	40
Contractor to notify Owner if, in his opinion, any of the equipment is in need of repair or replacement.	43
<u>Qualifications:</u> The successful Service Contractor must be performing monthly maintenance service in the Sacramento area at the present time and must be approved by the Architect.	46

SUBMITTALS

Drawings: Drawings are diagrammatic only, provide all material and labor required to make the system operate to the complete satisfaction of the Architect at no additional cost to the Owner.

Upon completion of the work, provide diagrams of the control systems, including a detailed description of the operation of each component and post in the Mechanical Room in plastic. Furnish a plot plan showing tubing runs, stubs for future, and major areas of control equipment.

Submit to the Architect for approval seven copies of shop drawings of the entire control system before starting work.

As Built Drawings: See Section 15A.

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SECTION 15C - PLUMBING AND UTILITIES

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RELATED DOCUMENTS

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The requirements of Division 1 apply to all work specified in this section.

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See also Section 15A, Mechanical Work - General Requirements, for additional provisions.

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DESCRIPTION OF WORK

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Provide all labor, materials and equipment required to furnish and install all plumbing work indicated on the drawings and described herein. Provide also any incidental work not shown or specified necessary to furnish the complete system.

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GENERAL

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Services: Make all arrangements for the utilities required. Pay all costs involved in obtaining the services, including gas service and meter, water meter and access box, street work, in lieu of fees for sewer, etc. Pay all costs for relocating, capping and rerouting existing services. Provide AWWA shut off valves for water main branches.

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Verify the location of all services; no extra cost shall be allowed if services are not as shown.

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Determine storm and sanitary sewer elevation at point of connection before installing any sewer piping. Notify Architect immediately if indicated grades cannot be maintained.

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As-Built Drawings: See Section 15A.

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Disinfection:

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Disinfect all water lines used for domestic supply. Amount of chlorine applied shall equal at least 50 parts per million for a period of 8 hours.

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Open and close all valves several times during the period, then flush out the system until the residual chlorine content is not greater than 0.2 p.p.m.

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MATERIALS

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Cleanouts shall be "T" or "Y" branches or trap hubs of same material as pipe in which they are placed. Cleanouts in cast iron lines shall have J.R. Smith #4400, Wade, or equal, cast iron bodies with brass plugs. Cleanouts in floors shall be J.R. Smith #4021 or 4161, Wade or equal, for tile floors, with nickel bronze covers. Cleanouts in vertical lines shall be J. R. Smith #4412, Wade or equal. Furnish cleanouts at ends of branch lines, at the base of vertical lines, at changes in direction and where shown or required to facilitate cleaning, a maximum spacing of 50 ft. inside buildings, 100 ft. outside. Cleanout to grade shall be set in a 14" x 14"

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x 5" deep concrete pad, trowel smooth and edge, set flush with finished grade. Cleanouts to be full size of line up to a maximum of 4". Cleanouts shall clear all obstructions by 18" minimum. Furnish to Owner one wrench for each size and type of cleanout used. Permanently identify cleanouts: SS for sanitary sewer and SD for storm drain.

Piping Connections: Minimum grade on drain, vent, and waste piping shall be 1/4" per foot unless noted, or later approved. Vent piping shall be graded to a soil or waste line.

Connections from stacks or horizontal wastes to wall or floor finish for wastes from lavatories, urinals, sinks, and drinking fountains and connection between floor drains and traps shall be I.P.S. 85% red brass pipe.

Special Equipment: Certain items of equipment will be furnished and set in place under a separate section of the specifications; furnish sink fittings and waste trap if required.

Make cold and hot water, drain, vent, and other required connections to all the equipment. Each water connection shall have a globe valve and union in the line, unless shown otherwise.

Provide grease interceptors of the size and types indicated.

Provide for the dishwasher a pressure reducing valve, Mueller or equal, with strainer, to operate at 180°F., together with Wade Shock-Stop, J. R. Smith or equal, shock absorber. Set pressure reducing valve for 20 psi discharge.

Sizes and locations of connections to special equipment are shown for equipment made by certain manufacturers. Secure rough-in data from the manufacturer for the equipment to be installed and rough-in accordingly. Final connections shall conform to the manufacturer's directions for the equipment furnished at no extra cost to the Owner.

Pipe & Fittings Inside Building:

See General Requirements Section for dielectric fittings and pipe protection. Terminate 10'-0" outside the building line or where marked.

Soil, Storm, and Waste Pipe underground and to 6" above ground, and soil pipe above ground: Extra heavy weight cast iron soil pipe and fittings, asphaltic coated, ASTM A-74.

Waste Pipe above ground from lavatories or sinks, condensate drains, and rainwater leaders above the floor: Schedule 40 galvanized steel pipe with black cast iron drainage fittings.

Vent Pipe 3" and larger: Service weight cast iron soil pipe and fittings, 2-1/2" and smaller: Schedule 40 galvanized steel pipe with

black cast iron drainage fittings, except all vent piping buried in the ground and to 6" above the ground: Extra heavy weight cast iron soil pipe and fittings.

Copper tubing (DWV or Type L) as allowed by local code may be used, including rainwater leaders and condensate drains.

Water Pipe (Hot and Cold Water): Type L copper tubing, hard temper, with wrought copper fittings. Capped or plugged outlets shall be Schedule 40 screwed brass.

Wet and Dry Standpipes: Schedule 40 galvanized steel with 300 psi galvanized or cadmium plated fittings.

Gas Pipe: Schedule 40 black steel with malleable iron screwed fittings above grade; welded below grade. Connect to each appliance including boilers with shut-off cock.

Pipe and Fittings Outside Buildings:

See General Requirements section for dielectric fittings and pipe protection. Connect to building services where terminated above.

Sanitary and Storm Drain Pipe: Service weight cast iron soil pipe and fittings, ASTM A-74, No-Hub pipe and fittings may be used only outside the buildings.

Water Pipe 4" and larger: Class 150 bell and spigot cast iron water pipe conforming to ASA A21.6. Pipe shall be lined with a factory applied 1/16" thick cement lining with smooth dense finish. Fittings shall conform to ASA Specification A21-10-1852, Class 250 pattern. Fittings shall be lined. Provide concrete thrust block at each change of direction.

Gas Pipe: Schedule 40 black steel with beveled ends for welding, with Class 150 welding fittings. Mitering to form elbows or tees will not be permitted, where branch tee connections of welded piping are required Bonney "Weldolet" fittings may be used, if the branch is one-half of the diameter of the main or less. Provide gas service shut-off valve on downstream side of meter conspicuously marked "GAS" with sign.

Flashing: Furnish and install around each pipe, where it passes through roof, a flashing and counterflashing. All flashings shall be made of four pound sheet lead with 8" minimum skirt, Semco 1100-2 or 1100-4 flashing fittings; Semco 1100-3, or 1100-5, M.D., J.R. Smith, or equal, vandalproof top and flashing combination for vents.

Manhole: 48" diameter precast reinforced sectionalized manhole risers and tops ASTM C-478-63T with "B" Wall. Manhole cone to be eccentric with traffic weight manhole frame and cover. Manhole to have integral non-corrosive steps. Provide concrete base, slab with inlets channeled to outlet. Entire installation to conform to local standard specifications. Refer to drawings for additional requirements.

Catch Basins: Basins are under Division 2, connect drain piping as shown and specified. 5
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Sump Pump: Duplex Automatic Sump Pump to be complete with grease lubricated radial ball thrust bearing in a cast iron dust proof housing located well above the floor level; cast iron casing and strainer; bronze enclosed impeller in natural hydraulic balance; enclosed steel hanger pipe; standard discharge pipe with expansion joints terminating above the floor plate in a 45° elbow; steel shaft ground and polished its entire length with bronze oil-less intermediate and casing sleeve bearings; all suspended from a cast iron floor plate. 8
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Pump to be directly connected by means of a flexible coupling to a totally enclosed electric motor. 17
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Pumps shall be automatically controlled by a Healy Ruff Roto-Trol sump control with automatic alternator that will alternate the pumps on each successive cycle, and shall also cause both pumps to operate if one pump cannot handle the load. 20
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Provide high water alarm of the contact, bearing diaphragm spring tension type and a chrome plated electric bell. 25
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Provide steel basin five feet deeper than the lowest inlet entering basin with cast iron cover to accommodate pump and control equipment with a suitable manhole. Coat basin inside and outside with 2 heavy applications of Bituplastic #28 before installation. 28
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Provide starter panel with all starting equipment including hand-off-automatic switch for each pump. 33
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Drinking Water Chiller: Haws unit of capacity shown on drawings. 36

Hermetically sealed refrigerant circuit with air-cooled condenser. Storage tank shall be stainless steel. 38
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Water chiller, storage tank and all refrigerant suction piping shall be insulated and vapor proofed. 41
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Provide a 5-year written warranty for entire refrigeration system. 44

Domestic water heater is included under Section 15B, connect piping systems as required. 46
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Fixtures and Trim: 49

Install all fixtures at locations shown on architectural drawings. 51
Provide proper backing for hanging brackets and hold down screws, 10 gage x 8 inch steel plate screwed or welded to 3 studs minimum. Grout voids between all fixtures and adjacent surfaces with clear Dow, G.E., or eq., Silicon Sealant. Wall hung water closets shall be mounted on Josam #M-150 Tru-Set, J.R. Smith, or eq., frame. Install hold down screws on wall hung lavatories. 52
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COMMUNITY CENTER COMPLEX - SAC

All exposed piping, bibbs, stops, faucets, traps, flush valves and other trim for all fixtures shall be chrome plated including piping inside sink cabinets. Provide Hudee rim for all counter type sinks and lavatories. Enameled ware shall be cast iron with acid resisting enamel.

Designations are American Standard, unless noted, Crane or Kohler are acceptable if equal in utility, quality and appearance.

Provide 85% IPS red brass pipe, securely anchored to building construction, for each connection to faucets, flush valves, stops, hose bibbs, etc. Isolate the pipe from the anchor with E-Z Isoliner (Milmac, San Francisco). Each fixture, including hose bibbs, shall have a stop valve installed on water supply lines to permit repairs without shutting off water mains. Provide air chamber on each fixture branch, 12" long by full pipe size. In addition, install a J.R. Smith 5020 Hydrotrol on the cold water piping adjacent to each room containing three or more plumbing fixtures. P traps for lavatories shall be Crane #8-5260, for sinks Crane #8-5272.

Concealed stops shall be 1/2" Crane #8H 2586, American Standard N-1434, 3/4" stops shall be Chicago #1771. Exposed stops and supplies shall be 1/2" Speedway #S3712A, lock shield, loose key.

Hose Bibb: 3/4" Acorn #8120, #8125 Nibco, or eq., pipe mounted, mount 18" above floor or finished grade, C.P. cast bronze, lock shield, loose key.

Hose Bibb in Wall Box: 3/4" Acorn 8100-2, Acorn, or eq., without plaster frame with anodized door.

Wash Down Station #1: Strahman Type M-144TM, Acorn, or eq., recessed type with corrosion resistant steel box with stainless steel door, valves and mixing unit, check valves and hose rack. Supply with 50 foot 5/8" white dairy hose assembly A.

Soap Tank and Piping: Bobrick, Acorn, or eq., size as shown on drawings, all types 302 stainless steel with exposed surfaces, satin finish, with tumbler lock all keyed alike, tank to swing down for easy filling with shut-off valve which automatically closes when tank swings down. Piping shall be 3/8" type "L" copper tubing with wrought copper fittings assembled with 95-5 solder and tested under 10 feet head of water for four hours.

Floor Sink: Graning #110, J.R. Smith, or eq., 12" x 12" x 10" deep, A.R.P.E. interior and #100-2 half grate, with #102 dome strainer.

FD-1, Floor Drain: J.R. Smith #2010A, Wade or eq., for exposed concrete, #2010B for tile floor, caulked, nickel bronze adjustable strainer, with flashing clamp where applicable; provide cast iron "P" trap.

FD-2, Floor Drain: J.R. Smith #2220, Wade, or eq., caulked, nickel bronze, cast iron "P" trap.

FD-3, Floor Drain: J.R. Smith #2010SB, Wade or eq., 5" x 17" strainer, with sediment bucket, caulked, nickel bronze, cast iron "P" trap.

<u>Roof Drain:</u> J. R. Smith #1310, Wade, or eq., duco coated.	5
<u>Hopper Drain:</u> J. R. Smith #3820, Wade, or eq., Lekcromate, 4" funnel top.	7
<u>Roof Receptor:</u> J. R. Smith #3990 Wade or eq., with underdeck clamp 12-1/2" diameter.	9
<u>Trap Primers:</u> E&S, J.R. Smith or eq., primer valve, connect as recommended by manufacturer.	11
<u>Quick Coupling Valves:</u> Nelson Midget Model 40ARLT Rainbird, or eq., with auxiliary valve to permit complete servicing of the valve from the top without turning off water supply. Provide reducing fitting on inlet to receive 3/4" pipe. Provide a hose swivel and operating key for each 2 valves. Valves shall match those furnished by landscape contractor.	13 14 15 16 17
<u>WC-1, Water Closet:</u> 2477.016 Afwall, wall hung, elongated, 9500 white seat, Sloan Royal 112YVQ flush valve, J.R. Smith carrier.	19 20
<u>UR-1 Urinal:</u> 6570.014 Jetbrook, wall hung, Sloan Royal 180YV flush valve.	22
<u>L-1, Lavatory:</u> 4300.042 Ledgewood, wall hung, 2412.013 perforated strainer waste fitting, Chicago 234-SLO metering faucet on right hand side, Bobrick B8612 vandal-proof lather soap dispenser on left hand side. No soap depressions will be allowed on lavatory.	24 25 26 27
<u>L-2, Lavatory:</u> 0476.028 Aqualyn, counter mounted, self-rimming, 2412.013 perforated strainer, Speakman S4321 metering faucet on right hand side, Bobrick B8684 lather soap dispenser on left hand side. No soap depressions will be allowed on lavatory.	29 30 31 32
<u>L-3, Lavatory:</u> Same as L-1 except without soap dispenser and with 2420.016 pop-up waste fitting.	34 35
<u>L-4, Lavatory:</u> Same as L-2 except without soap dispenser and with 2420.016 pop-up waste fitting.	37 38
<u>SS-1, Service Sink:</u> Florestone 24" x 24" x 12" with stainless steel cap on all exposed edges, tiling flange on edges adjacent to wall, 2" J.R. Smith #2070 all nickel bronze drain, American Standard 7593.148 faucet with vacuum breaker and 5 ft. hose.	40 41 42 43
<u>SH-1, Shower:</u> Florestone receptor with non-skid surface to suit Architectural drawings, color as selected by Architect, 2" J.R. Smith #2070 all nickel bronze drain, Acorn #802-2 shower head with vandal proof screws and anchor plate, Acorn Safti-Therm shower mixing valve.	45 46 47 48
<u>DF-1, Drinking Fountain:</u> Filtrine 102-66 Acorn or eq, stainless steel semi-recessed fountain fabricated of 16 gage stainless steel with #4 satin finish polished in one direction throughout. Fountain to be furnished with recessed push-button valve mounted on rim to operate concealed squirt-proof bubbler with "Auto-flo" regulator. Valve and bubbler shall be specially designed with built-in cushion effect to prevent mouth accidents while drinking and shall be insured against such liability. Bubbler to be located so as to provide minimum clearance of 26" between	50 51 52 53 54 55 56 57

rim and top of fountain recess, and 12" between bubbler and opposite side of fountain recess. Fountain to be mounted with concealed screws. Basin to be pitched 3/4" to drain, and insulated water will be chilled by remote unit.

DF-2, Drinking Fountain: Haws, Filtrine, or eq., custom terrazzo fountain to suit Architectural drawings, terrazzo materials shall be furnished by counter contractors to insure match of color and finish, three custom bronze "J" heads each with 5 PB custom bronze pushbuttons, center head on each fountain fitted with waste unit and strainer, side heads fitted with sloped matching base plates, all exposed metal custom bronze, wall mounting brackets anchored to 3/8" x 8" x 72" back plate anchored in wall.

DF-3, Drinking Fountain: Sunroc SR-CA, Haws, or eq., semi-recessed, all stainless steel including waste strainer, air-cooled, 1/5 H.P., 120 volt, 60 cycle, one phase, concealed water, waste, and electrical connection, coordinate electrical outlet location.

S-1 Sink: SSR1620 Sunset, 18 page stainless steel, sound deadened self-rimming, 16" x 20" x 8", 8310.070 faucet with aerator, 4331.013 waste fitting.

The following numbers refer to items of kitchen equipment and are not consecutive. Each item may occur several times. Provide a separate trap for each compartment of each sink in the kitchen areas.

K-6 Sink: 4219.036 faucet for cold water only, Just J15-SSF perforated strainer waste fitting. See drawings for faucet location.

K-7 Sink: Two 4146.015 swing spout faucets, Just J20-LAC lever action basket strainer waste fitting on right hand sink, connect disposer on left hand sink.

K-13 Sink: 8311.011 swing goose neck faucet, Just J20-LAC lever action basket strainer waste fitting.

K-15, Pot Washing Sink: Three 4146.015 swing spout faucets, three Just J20-BLA, Elkay, or eq., lever action waste fittings, Just J15-SSF, Elkay, or eq., perforated strainer in 6" wide sink compartment.

Pot Filler for K29 & 30: T&S, Chicago, or eq., mixing faucet with vacuum breaker, 84" long stainless steel hose with pot filler and squeeze valve, mount faucet at 48" above floor.

K-36, Troughveyor: 1/2" cold water, 1/2" hot water, 2" drain connection, provide valve and vacuum breaker on hot and cold water, provide 1-1/2" circulating piping as recommended by manufacturer.

K-38, Sink: T&S B-133 pre-rinse spray unit with B109 wall bracket except for cold water only, Just J-35 basket strainer waste fitting.

K-44 Sink: 4146.015 swing spout faucet, Just J-20-LAC lever action basket strainer waste fittings.

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K-58 Sink: 4146.015 swing spout faucet, Just J-20-LAC lever action basket strainer waste fitting.

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K-59 Ice Cooler: Provide Chicago 952, T&S, or eq., sill faucet with vacuum breaker and hose threads under counter.

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K-62 Beer-Soda Unit: Chicago 952 T&S sill faucet with vacuum breaker and hose threads.

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K-64 Soda Unit: Chicago 952 T&S, or eq., sill faucet with vacuum breaker and hose threads.

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K-67, Soft Drink Dispenser: Chicago 952, T&S, or eq., sill faucet with vacuum breaker and hose threads.

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K-69 Sink: Two 8311.011 faucets, three Just J-20-LAC, Elkay, or eq., lever action basket strainer waste fittings.

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FIRE HYDRANT

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Dresser #300, Potter Roemer, or equal; 4-1/2" valve size, one pumper, two hose connections, 6" inlet. Hose outlets shall be threaded for local Fire Department hose connectors. Pumper connection shall be set at 90° to curb line. Hydrant shall conform to and shall be installed in strict accordance with Standards of local authority.

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Underdrain System:

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Gravel: All stone or gravel used below the pipe and for backfill above the pipe shall be clean, crushed stone or gravel, carefully and evenly placed in order not to disturb the under drain piping.

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All under drain pipe shall be installed on 2" x 2" redwood levelling stakes on ten (10') foot centers, or equal. Levelling stakes shall be carefully placed in order to give the exact slope as shown or required for drainage. Batter boards shall be required to properly set the under drain pipe and determine the slope.

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Each length of pipe shall be marked by the manufacturer's name, size, and the word "Under Drain."

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All under drain pipe shall be inspected while being laid so that there are no obstructions inside the pipe which will prevent its proper use.

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Under drain piping shall be tested after backfilling and immediately before pouring floor slab by introducing approximately 100 gpm of water into the high end of each section of piping. Water shall flow freely into the sump and be clear of silt or sand.

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SUBMITTALS

Shop Drawings and fixture cuts will be prepared by the contractor for
submittal to the Architect. Prepare 7 copies of all items proposed to
be furnished.

SECTION 15D - KITCHEN REFRIGERATION

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RELATED DOCUMENTS

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The general provisions of the contract, including General Conditions and Special Conditions, apply to the work specified in this section. Applicable provisions of Section 15A - Mechanical Work - General Requirements also apply.

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12DESCRIPTION OF WORK

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Furnish and install all materials and perform all labor necessary for the complete installation of the Refrigeration Work indicated on the Mechanical drawings and described herein and any incidental work not shown or specified which can reasonably be inferred or taken as belonging to the work and necessary to provide the systems described or shown.

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20GENERAL

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In addition to the requirements of Section 15A provide the following:

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Refrigeration Piping Testing: The system shall be evacuated to 28" hg with a suitable vacuum pump. (The compressor shall not be used as a vacuum pump). The discharge from the vacuum pump is to be immersed in a vessel of oil and the evacuation shall continue until bubbles are no longer visible from the pump discharge. The vacuum shall then be broken with dry nitrogen and the evacuation repeated.

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At the end of the second evacuation, if the system has been proved to be leak-free, sufficient refrigerant shall be charged into the high side (receiver) and the proper amount of oil added to the compressor crankcase to maintain the oil level specified by the manufacturer. All refrigerant oil added to the compressor shall be delivered to the location in sealed containers.

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The system shall then be tested with a Halide torch. All leaks shall be repaired and the evacuation and test procedure repeated until system is proved leak free.

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Test water piping at 150 Psi for four hours with no visible leakage and maximum pressure loss of 5 Psi.

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Run an operating test of two 8 hour days to demonstrate proper operation of all components.

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Service: For a period of one year after final acceptance the contractor shall service the refrigerant systems at least every two months making a total of 6 service calls. This shall include replenishing all refrigerant and oil required to maintain proper levels without cost to Owner.

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MATERIALS AND EQUIPMENTRefrigeration Compressor:

Coplametic hermetically sealed unit with water-cooled condenser; capacity as noted with crankcase heater. Compressor to be provided with a separate high and low pressure control switch. High-pressure switch to be of the manual reset type.

Unit Cooler: Unit to be a regularly catalogued product of the manufacturer with published ratings. Unit to be provided with frames for ceiling suspension.

Pipe and Fittings: Refrigerant gas and liquid piping shall be Type "L" hard drawn copper tubing with wrought copper fittings. Lines shall be of sizes shown on the drawings. Extreme care shall be taken to keep the entire system clean and dry during installation. All lines shall be straight and free from kinks, restrictions or traps; horizontal suction lines shall be sloped toward compressor, 1" to 10'. All joints shall be made with high melting point solder, Sil-Fos.

All tubing must be evacuated and sealed at the factory. The seal must not be broken until ready for assembly. If there is any evidence of dust, moisture or corrosion, the tubing must be cleaned out by drawing a swab soaked with methyl alcohol or Freon through the tubing as many times as necessary to thoroughly clean the tubing.

Cooling water and drain piping shall be Type "L" copper tubing with wrought copper fittings. Unions to be ground joint all copper.

Appurtenances: Strainer, drier, valves to be Sporlan, Henry, Alco, Mueller.

Sight glass to be Sporlan See-All moisture and liquid indicator.

Solenoid and expansion valve to be Alco or Sporlan, of sizes shown.

Gauges to be James P. Marsh Company "Quality Gage," 3-1/2 inch diameter, recalibrating type. Provide one suction and one head pressure gauge for each unit, protect from vibration.

Thermometer to be Palmer 7-inch red reading Mercury industrial type, installed in each box.

Flexible pipe connections shall be Flexonic's metal hose, full pipe size; provide on each pipe connection to condensing unit.

Refrigeration Equipment: Mount cooling unit from ceiling construction with through bolts in a substantial manner. Seal vapor tight all penetrations through box walls or ceiling.

Mount compressor on sound isolating base on rigid racks.

Piping shall be securely supported from structure. Insulated piping shall be supported by hangers on the outside of the covering and the insulation shall be protected with 20 gauge sheet metal shields.

Run all drains from condenser and unit coolers to sump.

Mount pressure gauges and refrigerant valves and dryers on a neat panel mounted near the compressor. Panel shall be isolated from vibration.

Piping: Seal vapor tight all penetrations through box walls or ceiling.

Insulate all refrigerant suction piping with 3/4" nominal thickness Armstrong Armaflex or equal. Seal all joints with Armstrong 620 adhesive, or equal. Apply insulation in strict accordance with manufacturer's recommendations.

Condenser Water System: The condenser water system shall be a closed loop with the water pumped through the condensers, through the coil in an evaporative condenser, and returned to the condensers.

Evaporative condenser shall have copper coils; non-rusting and non-clogging sprays; hot dipped galvanized housing, frame, sump tank, eliminators, and fans; convenient access to sprays, float valve, sump tank, and eliminators; all bronze circulating pump; automatic bleed.

Provide expansion tank, cold water make up set, drain for closed loop and evaporative condenser.

Provide on each condenser a water regulating valve operated from head pressure with a maximum head loss of three feet of water.

SUBMITTALS

Provide 7 copies of technical data for equipment and parts as well as shop drawings for installation prior to delivery to job.

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SECTION 15E - TESTING AND BALANCINGRELATED DOCUMENTS

The general provisions of the contract, including the General Conditions and Special Conditions, apply to the work specified in this section.

DESCRIPTION OF WORK

Testing and balancing shall be performed on air distribution system, hot water heating system, chilled water system, domestic hot water system, chilled drinking water system, kitchen refrigeration system, and kitchen steam system.

GENERAL

Standards: Testing and balancing shall be performed in complete accordance with AABC National Standards for Field Measurement and Instrumentation, Form No. 81266, Volume One.

CERTIFICATION

The agency selected for testing and balancing shall be fully certified by the Associated Air Balance Council and shall have at least one member of the agency qualified as a certified test and balancing engineer, United States and Canada. All final reports shall be signed by this certified test and balance engineer and shall include his official stamp.

WORK TO BE DONE

The General Contractor shall obtain the services of an independent test and balance agency that specializes in and whose business is limited to the testing and balancing of air conditioning systems.

Testing and balancing agency as a part of its contract shall act as authorized inspection agency, responsible through the General Contractor to the Consulting Engineer and the Owner, and shall report any discrepancies or items not installed in accordance with contract drawings and/or specifications pertaining to the air distribution, cooling and heating and exhaust systems.

The General Contractor shall coordinate work done by the testing and balancing agency with work of other trades in the following manner:

Notify selected agency within 30 days after award of their contract so that the preliminary plan check and field inspection phase may be initiated.

Provide two sets of final prints of air conditioning plans for plan check purposes to test and balance agency prior to construction.

Direct installing contractor to make all necessary changes or

additions to air conditioning system on items reported by test
and balance agency to be not in accordance with contract drawings
and/or specifications.

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Inform test and balance agency of any major changes made to system
during construction and provide complete set as-built drawings.

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Instruments used for testing and balancing of systems must have been
calibrated within a period of six months and been checked for accuracy
prior to start of work.

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SUBMITTALS

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These copies of the complete test report shall be submitted prior to
final acceptance of the project.

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Selected agency shall submit AABC National Warranty Certificate which
includes pre-construction plan check and field inspection program
immediately upon receipt of test and balance contract.

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COMMUNITY CENTER COMPLEX - SAC

SECTION 15F - FIRE SPRINKLERS

RELATED DOCUMENTS

The general conditions of the contract, including General Conditions and Special Conditions, apply to the work specified in this section.

DESCRIPTION OF WORK

Furnish and install all materials and perform all labor necessary for complete installation of the Fire Sprinkler work indicated on the drawings and described herein, and any incidental work which can be reasonably inferred or taken as belonging to the work and necessary to provide the system described or shown.

GENERAL

Contractor shall not reduce the number of heads or pipe sizes below that shown. Additional heads or increased pipe sizes required by Pacific Fire Rating Bureau shall be provided at no extra cost. Location of heads and mains shall not be changed unless complete coordination drawings are submitted showing all mechanical and electrical equipment.

System shall comply with all applicable portions of National Fire Protection Association Pamphlet No. 13 for ordinary hazard.

Coordinate all piping with other trades on the job. Due to the limited space available, on the job measurement of pipe will be required. Offsets, pipe, fittings, drains, etc., required to meet job conditions shall be furnished and installed at no extra cost to the Owner.

The Fire Sprinkler Contractor shall make working drawings of the system and shall secure the stamp of the Pacific Fire Rating Bureau and approval by local governing Fire Authority and Building Inspection Department.

All work shall be done by a licensed fire sprinkler contractor. Electric connections to be done by Electrical Contractor.

Upon completion and prior to the acceptance of the installation, the Contractor shall subject the system to the tests required by the Pacific Fire Rating Bureau and shall furnish the Architect with a copy of the certificate required by the PFRB.

MATERIALS

Pipe: Schedule 40 black steel pipe with sprinkler fittings where above grade.

Pipe below grade shall be bell and spigot cast iron water pipe, AWWA Standard, Class 150, with fittings to match or where outside the building may be Transite Class 150 Industrial Pressure Pipe with Ring-Tite couplings, AWWA C400-53T. Fittings shall be cast iron pressure fittings with Ring-Tite bells, AWWA C100-55. Valves shall be cast iron pressure type.

COMMUNITY CENTER COMPLEX - SAC

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Hangers: National Fire Protection Association Pamphlet No. 13.

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Sprinkler Heads: Grinnell, Viking, or eq., flush type where mounted in finished ceiling, except Janitor Closets, Storerooms, or equipment rooms. All heads other than flush type shall have wire guards.

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Furnish six spare heads of each type properly boxed with sprinkler head wrench.

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Trim: O S & Y gate valve, check valve, electric alarm gong, pressure gauge, retarding chamber, testing bypass, ball check with pipe and fittings all in accordance with National Fire Protection Association

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COMMUNITY CENTER COMPLEX - SAC

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Couplings: Couplings shall not be used except where the length of pipe between fittings exceeds 20 feet.

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Flanged Fittings: Flanged fittings shall be used in the control valve and drain assembly at the base of risers.

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Where part of a sprinkler system is on the opposite side of a wall or partition, a flanged connection may be used.

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Sprinkler Heads: Clearances between the deflectors and the walls or ceilings, roof decking or roof joists shall be in accordance with the requirements of the NFPA Pamphlet No. 13 unless otherwise shown on the drawings.

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SECTION 15G - TEMPERATURE CONTROL MONITORING SYSTEM

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RELATED DOCUMENTS

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The requirements of Division 1 apply to all work specified in this section.

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DESCRIPTION OF WORK

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Provide all labor, materials, and equipment required to install a computer-oriented temperature control monitoring system as shown and as specified herein.

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GENERAL

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See Section 15A for general items.

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Coordination: The Automation Control Contractor shall coordinate the work of this section with the installation of heating, cooling, and ventilating equipment. His installation will be coordinated with items in Division 16.

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The Automation Control Contractor shall submit a list of two or more similar computer oriented installations, installed by them and in at least the initial stages of operation at the time of bidding.

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General Wiring: Under the electrical contract there will be provided separately fused 115 volt, 60 HERTZ, 30 amp power to the control console and 15 amp to each remote data gathering panel. Panel locations are shown on the mechanical plan.

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Service: The Automation Control Contractor must have had a service organization of at least three men servicing building control systems within 20 miles of this installation for a period of not less than 5 years previous to date of bidding.

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For initial checkout and future servicing it shall be possible to completely isolate any remote panel from the trunk wiring system and other remote panels by a single quick disconnect means. It shall also be possible to connect or disconnect individual function cards individually as a checkout or trouble isolation aid.

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The central processor shall be provided with four side access for service and installation. All central processor equipment shall be of the printed circuit board construction type for ease of removal and testing.

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Operating Instructions: The system supplier shall provide complete detailed written Operating Instructions and provide a minimum of two-day, on-site training of owner's operator. See Section 15A.

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MATERIALS

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Furnish and install where shown on the drawings, a Honeywell, computer-oriented, DataCenter, or Johnson T6500. System shall be completely modular,

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physically and electronically, and from a system configuration standpoint. It shall be possible, by plug-in module means, to field expand the basic system both in function and capacity to full on-line real time optimized computer control.

All processor cabinets, mode, and address switches necessary for full system expansion to at least 3900 points shall be furnished as a part of the initial installation. In addition, the expansion shall not require the addition of transmission trunk wires, change of sensors or controllers, nor require abandonment or replacement of any part of the base system.

Operators Console: A complete operator's console shall be provided, including all pushbuttons, indicators, switches, pilot lights, digital display annunciators, etc., required for the system. Input selection shall be via pushbuttons with lighted digital display of address selected. A single pushbutton labeled "enable" shall be provided and utilized by the operator to cause data associated with an input to be displayed. Analog values shall be displayed digitally to three places with appropriate engineering units displayed as two or three character alpha abbreviations. Status and digital alarms are to be displayed as three character alpha abbreviations along with address display.

The system shall include a "real" time clock with time displayed digitally. A 24-hour clock is used to generate interrupts and provide supervision and initiation of time determined functions and shall be keyboard resettable.

Alarm Reporting and Monitoring: The Data Center shall include a continuous all solid state scan and monitor system of 3900 point capacity with an actual sequential scan speed on binary alarm points of at least 350 points per second. Alarm reporting shall not be inhibited by keyswitch nor interfere with manual remote control and command functions. Scan systems which are dependent on alarm actuation shall not be acceptable. Alarm points shall be as shown on drawings.

Alarms shall automatically be displayed and identified by number and type on digital readout with the type of alarm word flashing until alarm condition is corrected. The audible sounds until the operator acknowledges. Return to normal of all alarms shall automatically display alarm identity and word NML. No audible is to sound on a return to normal.

All fans and pumps in an unauthorized ON or OFF mode, shall report as critical alarm points. Fans or pumps turned on or off locally shall cause the audible to sound, the alarm to be displayed, and word "ON" or "OFF" to appear flashing. The system shall include automatic time delay of alarming during start-up to preclude flow-switch false alarming.

The system shall include a minimum 15 word vocabulary, field reprogrammable, to identify different types of alarm and status conditions such as: ALM, FIR, SEC, OFF, ON, SLO, FST, and status words, such as: NML, ON, OFF, SLO, FST, CLG, HTG. Clearly defined two and three character alpha displays shall be provided for the following:

---Abnormal ON or OFF	5
---Fire Alarm	6
---Security Alarm	7
---General Alarm	8
---Slow	9
---Fast	10
---Heating	11
---Cooling	12
---Automatic ON	13
---Automatic OFF	14
---Occupied	15
---Unoccupied	16
---Maintenance	17

Upon alarm occurrence, the system shall automatically index the appropriate system and point. 19 20

System shall include automatic reporting of change of status of all alarms. 22 23

Start-Stop-Auto Control: Three-mode control capability shall be provided for remote control of motor loads or change-over functions, such as occupied, unoccupied, summer-winter, etc. Selection of controlled point shall cause digital display of address and current operating mode such as ON-OFF-AUTO, SLO-FAS-OFF, OC-UOC, HTG-CLG. 25 26 27 28 29

Status and Alarm Summary: Provide necessary mode control switches and circuitry to allow summaries of both Alarm and Status conditions. Upon command, sequential digital display of alarm point addressed shall occur, flashing to indicate alarm condition. For status summary, address display, plus alpha display of run condition or mode such as ON-OFF, HTG-CLG, etc. shall appear sequentially. 31 32 33 34 35 36

Analog Indication of Values: All temperatures shall be measured by electronic digital temperature transmitters of variable frequency type. Temperature sensor-transmitters shall be of the factory calibrated type, requiring no field recalibration. Sensor-transmitters are to be factory calibrated as a unit to 0.4F in a laboratory type constant-temperature bath. 38 39 40 41 42 43

As an option, resistance bulb bridge temperature measuring may be substituted, providing individual bulb-bridge per sensing point is provided and is complete with zero and span adjustment. Each bulb-bridge combination is field calibrated as a working unit to 0.4F in a constant temperature bath. Calibration methods such as decade boxes which simulate temperatures and do not test the sensor shall not be permitted. 45 46 47 48 49 50

All sensors are to be of the precision electronic type. In no case shall a single element be allowed to serve both local controller and remote indicator mechanisms. 52 53 54

All analog values shall be digitally displayed with address and engineering parameter such as DEG, RH, PSI. System supplied shall have 56 57

a vocabulary of 15 parameters, field reprogrammable thru system memory.
Two and three letter alpha abbreviation displays shall be provided for
the following engineering parameters:

Degrees	9
Relative Humidity	10
Pounds per Square Inch	11
Inches	12
Wet Bulb	13
Dew Point	14
Hours	15
Percent	16
Cubic Feet Per Minute	17
Gallons Per Minute	18
Tons	19
Kilowatts	20
Amperes	21
Volts	22
BTU's	23

Any system which does not always display sign, decimal point and
engineering unit parameter being measured will not be acceptable.

All analog values shall be sampled twice, compared for accuracy, and
then displayed with sign, value to three digits, decimal point properly
placed and engineering parameter shown. Chilled water and selected
space temperature to be displayed to tenths of a degree.

System shall have temperature range of at least -40F to +500F.

Graphic Display System: Color-coded, plastic, laminated, system-schematic
graphic, with all central-panel, remote-control and monitoring functions
indicated shall be mounted in a loose-leaf binder with tab indentities on
each relating to the selection system and typed operating instructions to
the operator. Provide space for temporary notes by operator. Provide on
the Console simple instructions for use of Central Panel.

Alarm and Logging Printer: System shall include wide-carriage, pedestal-
mounted, Teletype Model 33, page printer.

System shall be enabled to print all points in affected system when an alarm
occurs in addition to printing time, alarm point address and alarm type
identification. System shall include distinctive change of state print on
all alarm points.

System shall allow operator to log all points on all systems and their
value or status on demand as well as individual:

---Alarm summary log	53
---Status summary log	54
---Single group log	55
---Totalizer log	56

D I V I S I O N 16

ELECTRICAL

SECTION 16A - ELECTRICAL WORK - GENERAL REQUIREMENTSRELATED DOCUMENTS

The requirements of Division 1 apply to the work specified in this section.

DESCRIPTION OF WORK

This Section applies to all of Division 16. All conditions contained herein are pertinent to the other sections as if repeated in those sections.

In the event of conflict between this section and other sections of Division 16, the other sections shall govern.

Furnish and install any incidental work which can reasonably be inferred as part of the work and necessary to provide complete and workable systems.

Furnish and install all electrical systems as shown and specified, including wiring and connections to certain equipment furnished by others. Include trenching and compacted backfill for conduits in the ground.

WORK NOT INCLUDED

Furnishing of motors, fans, compressors, heaters and controls included under Mechanical Section.

Finish painting of exposed metal surfaces, included under Painting Section.

Equipment and work indicated "N.I.C." or "By Others."

Monthly Utility Company charges.

Telephone Company equipment and cable.

GENERAL:Standards & Codes:

California Administrative Code, Title 24.

State Building Standards.

National Electric Code.

Local City & County Codes.

Local Utility Company Regulations (as applicable).

WUESSC Standards.

General Order 95 of the Public Utilities Commission.

Nothing in the Drawings or Specifications is to be construed to permit work not conforming to these Codes and Standards.

In the event of conflict of the Drawings or Specifications therewith the Codes and Standards shall govern.

Wherever higher standards are indicated on the Drawings or Specifications these shall take precedence over the above Codes and Standards.

Coordination: Coordinate electrical systems installations with work of other trades. Examine the architectural, structural, mechanical equipment and special systems drawings and specifications to note all conditions affecting electrical systems installations and conflicts therewith. Report conflicting conditions to the Architect and obtain clarification before proceeding with work.

Should contractor proceed with work without so reporting matter, he does so on his own responsibility, and shall alter work if directed by the Architect, at his own expense. Right is reserved to make minor changes in locations of equipment and wiring systems shown, providing change is ordered before conduit runs and/or work directly connected to same is installed and no extra materials are required.

Examination of Site: As set forth in the GENERAL CONDITIONS of the Contract.

Permits & Fees: Obtain and pay for building permit for electrical work if required. Obtain any other required permits and pay any other fees in connection with all work of this Division 16.

Inspections: Arrange for and obtain inspections required by local ordinances.

Accuracy of Data: Existing conditions indicated on Drawings are as exact as could be obtained but their extreme accuracy is not guaranteed.

Layouts of wiring systems, equipment and accessories are diagrammatic (not pictorial) and are for assistance and guidance for the Contractor. Exact locations, distances, levels, etc., are to be governed by actual conditions.

Architect reserves right to make minor changes in locations of equipment and wiring systems indicated, at no extra cost to Owner, provided that this is ordered before conduit runs or other work directly connected thereto has been installed and that no extra materials are required.

UL Label: Electrical materials to bear UL Label or be listed by them, unless of a type for which label or listing is not provided.

Supervision: Maintain a competent electrical superintendent on the job from beginning of electrical work until completion and acceptance, using the same superintendent. Use same workmen as far as possible.

Manufacturer's Directions: Follow manufacturer's directions for points not covered by these specifications.

Protection of Materials: Protect materials from damage. Take special precautions to protect lighting fixtures and equipment against water, dust or other damage.

Adjoining Work: Protect adjoining work of other trades from damage that may arise from installation of the work of this trade. Repair or replace damaged work as directed.

Substitutions: When specific names are used in connection with materials, they are used as standards only, but this implies no right upon the part of the Contractor to use other materials or methods unless approved as equal in quality and utility by the Architect in writing.

Approval of a substitution does not authorize any deviation from the utility, size or function of the specified item unless specifically pointed out and approval requested in the letter of submittal. Responsibility for conflicts due to space limitations is not relieved by approval of a substitution.

If revision of wiring, piping, or arrangement of other equipment is required by substitutions, prepare Drawings showing such revisions, and after approval furnish the Architect with six (6) copies for file and future reference.

Guarantees: Acceptance of the Contract for this work includes this guarantee: The Contractor guarantees that he has performed the work in accordance with the Contract Documents.

Contractor agrees to replace or repair, as new, any defective work, materials, or part which may appear within one (1) year of final acceptance, if in the opinion of the Architect or the Owner the defect is due to faulty workmanship or material.

Warranties, Guarantees, Certificates, Etc., that are furnished and are available for equipment and materials furnished and installed under this section shall be properly filled out as of the date of acceptance of the work by the Owner and shall be delivered to the Architect.

MATERIALS

General Requirements: Unless otherwise shown or specified, material shall be new, full weight, standard, the best quality of its kind and satisfactory to the Architect.

Unless otherwise shown or specified, major equipment shall be the product of a manufacturer who has, for a period of not less than five (5) years, been in successful manufacture of the equipment and who has a nationally distributed catalog covering ratings and Specifications of said equipment.

Temporary Equipment and Materials: All temporary electrical equipment and materials installed for construction and safety operations shall remain the property of the Contractor and shall be removed when permanent connections have been completed.

No wire, bus or electrical equipment which is part of any of the permanent electrical systems may be used for temporary electrical service.

Temporary connections shall be safe and in accordance with accepted practices.

The Contractor shall be responsible for any damage or injury to equipment, materials, or personnel caused by improperly protected temporary installations.

All costs for materials and installation for temporary electrical facilities and energy for their operation shall be at the expense of the contractor.

Materials Standards:

NEMA	National Electrical Manufacturers Association
USAS	United States of America Standards
ASTM	American Society for Testing Material
IPCEA	Insulated Power Cable Engineer's Association
CBM	Certified Ballast Manufacturers Association

WORKMANSHIP

Good workmanship shall be evidenced in the installation of all electrical materials and equipment.

Equipment shall be level, plumb and true with the structure and other equipment.

All materials shall be firmly secured in place and adequately supported and permanent.

The requirements of the Codes are minimum standards.

The recommendations of the National Electrical Contractors Association Standard of installation shall be followed except where otherwise specifically directed.

INSTALLATION

Excavation and Backfill: Perform excavation and backfill required for electrical installation.

Restore all surfaces, roadways, walks, curbs, walls, existing underground installations to original condition in an acceptable manner.

Excavation: Dig trenches straight and true to line and grade, with bottom smoothed of any rock points.

Support conduit for entire length on undisturbed, original earth. Minimum conduit depth of pipe crown shall be 1'-6" below finished or natural grade.

Backfill: All backfill material, placement and compaction shall conform to applicable requirements of Division 2.

Working Space: Adequate working space shall be provided around electrical equipment in strict compliance with the Codes. In general, provide 6'-6" of headroom and 30 inches minimum clear work space in front of panelboards and controls for 208 volts and 42 inches for 480 volts.

Structural Requirements: Installation under this Section shall comply with the Uniform Building Code.

Flashing and Sealing: Flash and counterflash roof and wall penetrations in manner described under other applicable sections of this specification and as approved by the Architect.

Conduits, ducts, etc., passing through finished walls shall be fitted with steel escutcheon plates, chrome or paint finish as directed. Conduits which penetrate floor slabs and concrete or masonry walls shall be grouted and sealed watertight at penetration.

Electrical Work for Motors and Equipment Furnished by Others: Make all necessary electrical connections to all motors and equipment furnished and installed by others.

Connection points and specific power and control requirements shall be obtained from others and used to perform electrical work.

Assist others in testing of their systems where use of electrical power is required, but this Contractor's responsibility is limited to having correctly installed and connected electrical work in accordance with diagrams and specifications furnished him by others.

All control wiring, both line and low voltage, shall be furnished and installed by this Contractor.

All motors, starters and disconnect switches shall be furnished by this Contractor except for those starters and disconnects specified to be furnished with the equipment.

IDENTIFICATION OF EQUIPMENT

Nameplate material shall be laminated phenolic plastic, black front and back with white core.

Engraving shall be through the outer layer.

Embossed plastic pressure sensitive labels are not acceptable.

In lieu of plastic plates, device plates shall be engraved directly with lettering filled with black enamel.

Nameplates shall be installed on electrical equipment. Equipment to be labeled shall include the following:

Individual enclosures such as disconnect switches, time switches, push buttons, contactors, relays, motor starters, etc.

Group mounted equipment such as panelboards, switchboards, motor control centers.

Individual circuit breakers on switchboards.

Wall switches for lighting or other use where the control function is not self evident.

High voltage boxes and cabinets.

Nameplates shall adequately describe the item and its function or use of the particular equipment involved.

A nameplate shall be attached to the Main Switchboard stating the name of the building, year completed, name of the Electrical Engineer and name of the manufacturer with his identification number and nothing else.

Nameplates shall be securely fastened to the equipment with #4 Phillips round head cadmium plated steel self tapping screws, or brass bolts.

CLEANING

After all work has been accomplished such as sanding, painting, etc., lighting fixtures, panelboards and switchboards shall be cleaned to remove all dust, dirt, grease, paint or other marks. All electrical equipment shall be left in a clean condition inside and out, satisfactory to the Architect.

TESTS

Test all wiring and connections for continuity and grounds before any fixtures or equipment are connected and where such tests indicate faulty insulation or other defects, they shall be located, repaired and retested at the Contractor's expense. Electrical loads shall be balanced at the panelboards. Rotation of all motors shall be checked and corrected, if necessary, after final connections are made.

DEMONSTRATIONS

The Contractor shall provide, without additional expense to the Owner, the services of competent individuals who will give full demonstration of the significant uses and actual operation of each electrical item and system herein specified.

The individuals providing demonstration may be in the employ of the Contractor or may be the authorized representative of the manufacturer of the particular electrical item or system demonstrated.

Demonstrations shall not be held until after project final inspection. All electrical items and systems shall have been inspected and tested to the satisfaction of the Architect to assure their compliance with the Drawings, Specifications, Codes, etc., and to assure these systems are in good working order.

The performance characteristics of each completed electrical system must be found satisfactory before the demonstration begins.

Each system shall be demonstrated once only, after completion of testing, on a date to be agreed upon in writing by the Owner's designated representative.

The demonstration shall be held in the presence of the Owner's designated representative, the Architect or his Engineer, and the manufacturer's representative.

The demonstration shall show the functions and location in the structures of each system. Demonstrate by "start-stop operation" how to work the controls, how to replace and reset protective devices, how to replace lamps, how to gain access to control and protective devices, and what to do in case of emergency.

Additional specific requirements may be included in the separate sections of this electrical specification.

The following items and systems shall be demonstrated:

Signal Systems:

Alarms & Bells
Fire & Smoke Detection Devices
Intercommunication Equipment

Electrical Entrance Equipment:

Circuit Breakers
Fuses and Fuseholders

Electrical Systems Control & Equipment:

Electrical Power Equipment
Motor Control Centers
Motor Control Devices
Relays & Contactors
Transformers
Starting Devices

Lighting Fixtures:

Exit & Safety Fixtures
Fixtures, Indoor & Outdoor
Floodlighting

Panelboards:

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Stage Lighting Controls

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Dimmer Equipment

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Distribution Panels

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Lighting Panels

10

Main & Power Panels

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Switchboards

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Standby Electrical Equipment:

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Batteries & Chargers

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Fuel System

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Motor-Generator Set

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Transfer Switches

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Controls

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Wiring Devices:

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Low Voltage Controls

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Outlets; Convenience, Special Purpose

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Switches; Regular, Time

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SUBMITTALS

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Materials List & Shop Drawings: Within thirty-five (35) days after award of the Contract, submit six (6) bound copies of complete material list, including manufacturer's name and catalog numbers.

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All material specified herein and on the Drawing shall be included in list. Proposed substitutions shall be accompanied by catalog cuts, ratings, sizes, performance curves, shop drawings and other data complete to prove full equality to the specified item.

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All shop drawings and supporting data shall be submitted as instruments of the Contractor. Contractor shall place his stamp on each sheet of submittal documents, thereby stating that the equipment meets all requirements of the Contract Documents and conforms to structural and space conditions. At least one set of submittals shall have check marks at each item indicating that the Contractor has verified compliance with above requirements.

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Should the Contractor fail to submit the specified items within the time schedule or fail to name items meeting Specifications then the right is reserved by the Architect to select any or all items in question which selection shall be final and binding upon the Contractor. The materials selected or approved by the Architect shall be used in the work at no additional cost to the Owner.

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Whenever an item of equipment or system is described herein or on the Drawings in a descriptive, functional or operational as opposed to catalog number of type, then the Contractor's submittal shall include all such descriptive, functional or operational features to prove full equality to specified item or system.

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Should the Contractor's first submittal fail to meet approval then the right is reserved by the Architect to select any or all items and systems and which selection shall be final and binding upon the Contractor.

The items or systems selected or approved by the Architect shall be used in the work at no additional cost to the Owner.

Within ten (10) days after return of material list, submit six (6) bound copies of brochures containing complete information and catalog cuts on all equipment, including that which is to be furnished as specified. The brochures shall be bound as complete volumes or bound according to classifications of equipment such as power, fixtures, signals and miscellaneous.

Panelboard submittals shall be arranged to show bussing and circuit numbers with respective branch circuit protective device similar to schedules on Drawings.

Switchboard and motor control center submittals shall show elevations indicating layout of devices, metering, etc.

Device ratings, circuit numbers and nameplates shall be in table form. Terminal cabinet submittals shall include elevations with terminal strip mounting arrangement.

Samples: Samples of fixtures, materials and equipment shall be submitted for approval of Architect, if requested.

Manuals: In addition to the catalog data and Shop Drawings submitted for approval as required hereinbefore, the Contractor shall furnish to the Architect three (3) final corrected sets of all data applicable to the equipment furnished.

All data shall be delivered not less than 30 days before the start of operation by the Owner or any demonstration period herein specified.

Each set of data per system shall be bound in one or more volumes. A top quality three-ring binder with vinyl or hard cover will be acceptable in lieu of binding; however, all insert data must be properly punched and reinforced. Each volume shall have permanent identification information on the spine.

Identification information shall include the building name, address, and location, system or systems included and titled "Maintenance Manual." All data shall be assembled in an orderly sequence with tabbed dividers to correspond with the table of contents. Manufacturer's catalog data, Shop Drawings, etc., shall be marked clearly to identify the items applicable only to this project. Make and model numbers of each item installed shall be marked clearly in catalog data and identified with symbol used on the Drawings.

Each set of data shall contain the following:

Table of Contents, listing orderly indexed names of items.

	2
Descriptive literature.	5
Rating data, including rating tables, performance curves, etc.	7
Dimension data.	9
Spare parts Lists.	11
Manufacturer's operation and maintenance instructions and manuals.	13
Shop Drawings.	15
Copies of posted instructions and diagrams.	17
Control diagrams and descriptions of sequence of operation.	19
Complete data shall be provided on each item listed below, including	21
Component Parts:	22
Switchboards	24
Underfloor Raceways	25
Panel Boards	26
Fire Alarm Equipment	27
Lighting Fixtures	28
Motor Control Centers	29
Motor Starters	30
Sound & Signal Equipment	31
Standby electrical equipment	32
Stage lighting equipment	33
<u>As-Built Drawings:</u> The Contractor will be furnished with a sepia set of	35
Electrical drawings from which he will make two (2) sets of white prints.	36
One (1) set shall be marked as the work is installed showing the work that	37
has been installed. The other set shall be marked showing deviations from	38
the work shown and the locations of major items of equipment and feeders,	39
dimensioned from column or wall lines. Contractor shall submit the	40
corrected set to the Architect for recording.	41

SECTION 16B - BASIC MATERIALS AND METHODSRELATED DOCUMENTS

The requirements of Division 1 apply to all work specified in this section.

DESCRIPTION OF WORK

This section applies to all of Division 16. All conditions contained herein are pertinent to the other sections as if repeated in those sections.

GENERAL

See Section 16A - General Electrical Requirements for information regarding this Division.

MATERIALS

Raceways: Unless otherwise specified, all conduit and EMT shall be installed concealed. Conduit and EMT may be run exposed on unfinished walls, in penthouses, attics and roof spaces and elsewhere as indicated on drawings, when run to surface cabinets, panels or gutters.

Multiple (trapeze) pipe hangers shall consist of two or more steel hanger rods, a steel horizontal member and all U-bolts, clamps and other attachments necessary for securing hanger rods and conduits. Hanger rods shall be threaded either full length or for a sufficient distance at each end to permit at least 1-1/2 x 1-1/2 inch, No. 12 gage, cold formed, lipped channels designed to accept special spring-held, hardened steel nuts for securing hanger rods and other attachments. Two or more channels may be welded together to form horizontal members of greater strength than single channels.

Pipe straps and hanger rods shall be fastened to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts, and to hollow masonry by means of toggle bolts. Expanders and shields shall be steel or malleable iron. Sizes of shields and bolts shall be such that the proof test load will not be less than four times the actual working load. Wooden plugs and lead shields shall not be used for fastening pipe straps and hangers nor shall perforated strap iron or nail type straps be used.

Individual horizontal conduits and EMT not larger than 1-1/2 inch size shall be supported by means of one hole pipe straps or individual pipe hangers. Individual horizontal conduits and EMT larger than 1-1/2 inch size shall be supported by individual pipe hangers. Above accessible ceilings, spring steel fasteners, clips or clamps specifically designed for supporting exposed single conduits up to 1" size may be used in lieu of pipe straps or pipe hangers. Hanger rods used in connection with spring steel fasteners, clips and clamps shall be either 1/4 inch diameter or larger galvanized steel rods.

Where two or more horizontal conduits or EMT run parallel and at the same elevation, they shall be supported on multiple (trapeze) pipe hangers. Each conduit or EMT shall be secured to the horizontal hanger member of a U-bolt, one-hole strap or other specially designed and approved fastener.

Vertical conduits and EMT not larger than 1½ inch shall be supported by riser clamps at each floor or by one hole pipe straps not over 8 feet apart. Vertical conduits and EMT larger than 1½ inch shall be supported by riser clamps at each floor. Short vertical drops larger than 1½ inch shall be supported by hangers close to the elbows at the tops, and additionally secured to walls, columns, etc., by one-hole pipe straps spaced not over 8 feet apart.

Conduits and raceways above suspended ceilings shall be supported from floor or roof structure above except that conduits ¾" and smaller serving equipment installed in the ceiling may be supported from the main ceiling support members by use of approved spring steel clips or fasteners.

In any conduit or EMT run, the number of ¼ bends, or the equivalent, between terminations at cabinets, outlet boxes, junction boxes and pull boxes, shall not exceed the number of ¼ bends indicated below, and the total length of run shall not exceed 150 feet. Straight runs of conduit shall not exceed 250 feet in length between terminations at cabinets, outlet boxes, junction boxes and pull boxes.

Conduit Size - Inches	Number of ¼ bends
½ to 1½	4
1½ to 2½	3
3 to 4	2

The size of each run of rigid conduit, flexible metallic conduit or EMT shall be the largest of the following:

- (1) The minimum size shall be ¾ inch, except above accessible ceiling, in which case it may be ½" minimum. Telephone conduits shall be ¾" minimum.
- (2) The size noted on the drawings.
- (3) The size required by codes to accommodate the number, size and type of wires shown or specified or recommended by the manufacturer of the equipment served.

The Contractor's attention is directed to check the size of all raceways to determine that the green equipment ground conductor specified, shown or required, can be installed in the same raceway with phase and neutral conductors in accordance with the percentage of fill requirements of codes. If necessary the Contractor shall increase the duct, conduit, tubing or raceway sizes shown or specified to accommodate all conductors without additional cost to the Owner.

Expansion Joints: Attention is called to the expansion joints which occur at intervals in the construction. Where crossings are unavoidable, conduits shall cross at right angles with an expansion sleeve fitting. The expansion fitting shall be of a type designed to compensate for expansion and contraction in a line of conduit. The expansion end shall be sealed by a high grade packing which will prevent the entrance of water or moisture. End of conduits shall be provided with insulated bushings. Copper grounding rings or an auxilliary flexible bonding jumper, carefully installed to insure proper operations, shall be provided to secure a continuous ground between conduit and fitting.

A conduit expansion fitting shall be installed in each conduit run wherever it crosses an expansion joint in the concrete structure. The expansion fitting shall be installed on one side of the joint with its sliding sleeve and flush with the joint and with a length of bonding jumper in the expansion joint equal to at least three (3) times the nominal width of the joint.

These fittings shall also be provided where expansion and contraction are a consideration in long runs of conduits.

Minimum size underground conduit shall be 3/4 inch.

Conduit caps shall be installed during construction.

Underground conduit bends shall have a minimum radius of 12 times the conduit trade size.

Telephone and signal conduit bends shall have a radius of 10 times the conduit trade size.

Pull wires shall be provided in all empty conduits and shall be #12 TW in conduits 1-inch and smaller and 3/16-inch polypropylene rope in conduits 1 1/4 inch and larger.

Conduit Location Marker: All underground stubs shall be identified with capped conduit stake at end of stub. Provide stake cap with non-corrosive tag identifying source of stub. Set stake 1-inch above final finished grade before backfill of trench. At completion of job and after Owner has been shown location of stakes, drive stakes flush with grade. All conduit stubs shall extend 5 feet beyond sidewalks or concrete curbs, footings, etc.

Plates and Grouting: Conduits, ducts, etc., passing through finished walls shall be fitted with steel escutcheon plates, chrome or paint finish as directed. Conduits which penetrate floor slabs and concrete or masonry walls shall be grouted and sealed water-tight at penetration.

Conduit Fittings: Except where otherwise noted, conduit fittings shall be Appleton, Crouse-Hinds or equal. Unilets shall be malleable iron and fitted with cover and gasket.

Conduit Supports: Kindorf, Unistrut, T & B or equal. All multiple hanger & support parts shall be zinc-coated by hot dipping or electroplating or otherwise protected against corrosion. 5
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Conduit Straps: T & B, Gedney, or equal one or two hole malleable iron or snap type steel with ribbed back, galvanized or cadmium plated. 9
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Rigid Steel Conduit: Standard weight, zinc coated on outside by hot dip galvanizing process, with either zinc coated or other approved corrosion resistant coating on inside. 12
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Fittings shall be threaded and finished similar to conduit. Threadless fitting shall not be used. All joints shall be redlead, except where conduit is run in permanently dry locations. 16
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Where installed in contact with earth or fill material, conduit shall be wrapped with not less than 4 layers of Scotchwrap #50, Johns-Manville VLD-10 or approved equal, or encased in 3-inches of concrete. Follow any specific instruction or methods shown on Drawings. 20
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Conduits connected to boxes and cabinets shall be fitted with two locknuts and insulated busing, OZ "B" Series, Gedney or equal, unless grounding bushings are required. 25
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Conduits not connected with locknuts and bushings shall be fitted with insulated grounding busing, OZ "BL" Series, Gedney or equal, UL approved and bonded. Grounding bushing shall be used whenever grounding conductors are installed. Conduit stubs shall be capped with coupling, nipple, coupling and plug. 29
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Conduits connected to boxes, cabinets, etc., exposed to weather or in areas subject to excessive moisture shall be fitted with watertight sealing hubs of steel or malleable iron with sealing ring and insulated throat, T & B 370 Series, Efcor 40-50B Series or approved equal. 35
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Flexible Metal Conduit: Minimum trade size - 1/2 inch. 40

Connectors: T & B "Tite Bite" Gedney or equal, insulated. Where used for connection of recessed fixtures, connectors may be of the type that screws into inside of conduit, Efcor 1100 Series, Gedney or equal. Suitable for connection of recessed fixtures, controls, mechanical equipment and other equipment subject to vibration or movement; not permitted here exposed to weather or other wet or corrosive conditions. 42
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Length shall be a practical minimum but to allow for movement of equipment connected without restricting flexibility of conduit. 49
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Liquid Tight Flexible Metal Conduit: Minimum trade size 1/2 inch. 52

Connectors: Appleton STB Series through 2-inch trade size and ST Series with insulated bushings over 2-inch trade size. Appleton, Crouse-Hinds, or approved equal, may be used. 54
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COMMUNITY CENTER COMPLEX - SAC

Length shall be practical minimum but to allow for movement of equipment connected without restricting flexibility of conduit.

Electric Metallic Tubing: Rolled steel, zinc coated outside with either zinc coated or other approved corrosion-resistant coating on the inside. Maximum trade size, 2-inch. Couplings shall be rain tight compression type Appleton 95-T Series, T&B 5123 Series, or approved equal. Connectors shall be rain tight compression type with insulated throat Appleton 86-T Series, T&B 5123 Series, or approved equal.

E.M.T. may not be used:

Underground, in concrete, exposed to weather or other moisture laden or corrosive locations.

COMMUNITY CENTER COMPLEX - SAC

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Continuation of run above grade, slab or into building interior shall be with rigid steel.

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Dust separation specified on Drawings shall be provided using plastic conduit spacers specifically designed for the purpose. Place spacers maximum 4'-0" o.c.

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Conduit and fittings shall be one of the following:

Asbestos Cement, meeting Federal Specification WC-571, latest revision, UL labeled.

PVC Plastic, UL labeled, meeting the requirements of MATERIAL SPECIFICATIONS FOR PLASTIC SEMI-RIGID CONDUIT AND FITTINGS shown herein below.

Rigid steel conduit, long radius bends shall be used for all changes in duct direction greater than 10°.

Factory end bells shall be used at the terminations of the conduit within manholes and vaults. The end bells shall be compatible with the conduit used.

All couplings shall be those recommended by the manufacturer of the conduit used. They shall fit the conduit securely.

Adapters necessary for the transition from metallic conduit to non-metallic conduit shall be of the same manufacture as the non-metallic conduit used.

All materials shall be subject to the approval of the SMUD inspector. Fractured, broken or otherwise imperfect materials shall not be used in the work.

Conduit Manufacture

The material used, maximum manufacturing tolerances, radius of bends measured along the centerline, and tangent lengths, workmanship, and other details shall be in accordance with Western Underground Committee Specification No. 3.1, latest revision and with SMUD Spec. 911.

Identification and Marking

The conduit shall be marked as indicated in Paragraph 6.4 of the Western Underground Committee Specification No. 3.1, latest revision and bear the UL label.

Installation: The conduit line shall be installed where shown on the drawings and installed to drain toward either or both ends, except where otherwise approved by the Inspector.

Conduit runs staked vertically shall have staggered joints except at sweeps and transitions.

Conduit shall be spaced vertically and horizontally such that a minimum separation of 1-1/2 inches shall be maintained between the outside surfaces of the conduits.

Conduits and spacer assembly are to be firmly secured and tied down to prevent displacement of "floating" of the conduits as the concrete is placed.

No wood shall be left in the concrete encasement or backfill. Metallic tie wire or tie downs may be used only when such tie wire completely surrounds the entire duct bank.

Non-metallic conduit shall be placed so as to maintain 30 inches minimum cover unless otherwise shown by the Plans, or approved by the Inspector. Cover will be measured from finished grade to top of encasement.

A 3/16 inch polypropylene rope shall be left as a "sleeper" in each conduit.

The ends of each piece of conduit shall be reamed.

Installation of Type I or II Conduit: All non-metallic conduit shall be concrete encased. Concrete for conduit encasement shall be a mix consisting of 3/8 inch maximum size well graded, washed, naturally round, aggregate, five sacks of Type I cement per cubic yard and have a slump not to exceed 8 inches. An air entraining agent may be used at the option of the Contractor, upon approval of the Inspector.

With Type I asbestos cement conduit, two spacers per length of conduit shall be used; with Type I plastic 3 inch or more, a spacer shall be placed every 4 feet; for 2-1/2 inch or less, a spacer shall be placed every 2 feet. All plastic conduit shall be installed according to the manufacturer's recommendations and as approved by the Inspector. Spacers shall be made of non-metallic materials.

Surfaces upon which concrete is to be placed shall be free of standing water, mud and debris. Absorptive surfaces against which concrete is to be placed shall be moistened.

Cold joints, where necessary in concrete encasement, shall be made of a uniformly sloping plane at the angle of repose of the fresh concrete and shall be roughened. Before commencing the next pour, the surface of previously placed concrete shall be thoroughly cleaned.

Concrete shall be placed only in the presence of the Inspector.

Concrete shall be placed to form a duct encasement of at least 3 inches on all sides between the outer surfaces of the envelope and the surface of the nearest conduit.

Concrete encasement shall extend over, and a minimum of 2 feet beyond, the connection of metallic conduit to non-metallic conduit.

Concrete is to be placed over the assembled duct and hand worked to completely fill all voids between conduits and between conduits and earth or forms.

Any concrete which has been mixed 90 minutes after initial addition of water shall not be used in the work.

White pigmented curing compound shall be applied to the top of the exposed concrete as soon as the surface moisture has evaporated; or in lieu thereof, by any other satisfactory curing means approved by the Inspector.

Installation of Rigid Steel Conduit shall be as hereinbefore specified.

Inspection: After encasement and backfill for the conduit is completed, the Contractor shall perform tests by drawing through each conduit a mandrel of appropriate size as approved by the Inspector. SMUD will furnish the mandrel and a brush for the 3", 4" and 5" conduit runs. The Contractor shall furnish the mandrel for all other conduit sizes. The mandrel tests shall be witnessed by the Inspector, and the Contractor shall notify SMUD 24 hours in advance of the tests.

A brush shall not be used in any plastic conduit.

Cable Tray: Steel, solid bottom with solid cover as manufactured by Globe Division of U.S. Gypsum, Burndy or eq. Tray shall have a clear inside width, with top flanges turned out of depth and width as shown on drawings. Fittings, both vertical and horizontal, shall have 12" minimum radius. All fastener heads inside tray shall be button-head design. All expansion or adjustable splices shall be equipped with a bonding jumper cable. Tray, fittings, and all accessories shall be hot dip galvanized.

Provide all accessories, supports, etc., necessary for a complete installation in complete conformance with applicable codes.

Surface Raceway Assembly: Wiremold 700 series General Electric or equal, surface wiring system finished in ASA-61 gray. Furnish complete with couplings, elbows, fittings, boxes, etc., necessary to make a complete installation.

Boxes:

Outlet Boxes: Outlet boxes shall be one piece deep-drawn steel, galvanized gang type. Octagon concrete rings may be folded type. Sectional boxes shall not be used. Boxes installed in any exterior location, where exposed to rain or where exposed to moisture laden atmosphere shall be cast screw hub type with gasketed weatherproof covers. Boxes for vapor proof or explosion proof applications shall be designed specifically for such use.

Each box shall be large enough to accommodate the required number and sizes of conduits, wires, splices and devices but not smaller than size shown or specified. Unless otherwise specified or shown on drawings, boxes shall be flush mounted with front edge of box or ring flush with wall or ceiling finish. Use plaster ring in plastered or gypboard applications.

Switch, receptacle and telephone boxes shall be not less than 4 inches square by 1-1/2 inches deep for single devices; 4-11/16 inches by 1-1/2 inches deep for two devices, where installed in unfinished areas, exposed, boxes shall be cast screw joint type or other type that does not have unused knockouts.

Outlet boxes mounted in cabinets, tile, concrete block, brick, stone, wood or similar material shall be rectangular in shape with square corners and straight sides and installed without plaster rings. Such boxes shall be 3-11/16 inches high by 2-1/2 inches wide by 3-1/2 inches deep for a single device, or shall have suitable tile or masonry ring for larger box.

Lighting outlets shall be 4 inch octagon, minimum, fitted with 3/8 inch malleable-iron fixture stud.

Boxes for special devices such as clocks, speakers, fire alarm, television and the like shall be particularly suited for the intended use.

Boxes shall be accurately placed as shown on drawings or as close thereto as possible. Contractor shall refer to drawings, specifications and submittals covering work of the other trades to coordinate outlet location. In the event of conflict between planned location of outlet and other equipment or furnishing, contractor shall not proceed until direction has been given by Architect or Engineer.

Mounting height of wall mounted outlet means height from finished floor to horizontal centerline of cover plate. Heights shall be as follows unless specifically noted otherwise on drawings:

Receptacles: +1'-6". Outlets in cabinet backsplash or in wall above backsplash shall be arranged for horizontal device installation. Wall outlets shall be arranged for vertical device installation.

Switches: +4'-4"

Telephone: +1'-6" (See note above for receptacles.)

Junction Boxes: Junction boxes having internal volume of not over 100 cubic inches shall be as hereinbefore specified for outlet boxes, but not including fixture stud, and shall have blank covers. Boxes shall be galvanized steel.

Junction boxes having internal volume of more than 100 cubic inches shall be as hereinafter specified for pull boxes.

All junction boxes shall be installed so that covers are accessible after completion of the installation.

Boxes exposed to rain or installed in wet locations shall be specifically designed for the purpose.

Junction boxes shall not be installed in finished areas unless specific approval for such installation is granted by Architect.

Pull Boxes: Pull boxes having internal volume of not more than 100 cubic inches shall be as hereinbefore specified for outlet boxes, but not including fixture stud, and shall have blank covers. Boxes shall be protected from corrosion.

Pull boxes having internal volume greater than 100 cubic inches shall be of panelboard type construction except that covers shall be secured by screws or bolts.

Boxes exposed to rain or installed in wet locations shall be specifically designed for the purpose.

All pull boxes shall be installed so that covers are accessible after completion of the installation.

Pull boxes shall not be installed in finished areas unless specific approval for such installation is granted by Architect.

Box Mounting: Boxes shall be independently and securely supported in place by wood backing or manufactured adjustable channel type hanger, Steel City, Raco or approved equal. Use screws to fasten to wood back or metal stud. Single side strap mounting shall not be used. Boxes installed in masonry, tile or concrete block shall be secured with auxiliary plate or bar and be grouted in place. Surface boxes shall be supported with expansion screws, bolts, or anchors. Suspended boxes shall be supported with threaded rods or strut assemblies attached directly to structural members by means of bolts or anchors.

Precast Concrete Boxes:

Boxes: Precast high-density reinforced concrete with end and side knockouts and extension as required. Provide exterior shoulders to prevent settlement in traffic areas. Provide poured concrete footing formed inside with 6-inch gravel in bottom of box to facilitate drainage.

Covers: Precast, reinforced concrete with hold-down bolts. Traffic covers, where required, shall be steel checker plate, galvanized, with hold-down bolts. Covers shall be factory marked as follows:

SYSTEM

MARKING

Power 600 volts or less
Power over 600 volts
Telephone
Clock, Unified Signal, etc.
Fire Alarm

Electrical
High Voltage
Telephone
Signal
Fire Alarm

Television	T.V.	2
Traffic Signal	Traffic Signal	5
Street Lighting	Street Lighting	6
Lighting	Lighting	7
Grounding	Ground	8
		9
<u>Floor Boxes:</u>	Floor boxes shall be heavy duty, cast type with threaded hubs and height adjustable cover, Hubbell Dual level or approved equal with device or service fitting as shown on drawings.	11
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		13
<u>Conductors:</u>		15
Conductors for power, lighting, control and signals shall be in raceways and shall be as follows:		17
		18
Minimum size branch circuit shall be #12AWG.		20
Minimum size mechanical equipment control circuits shall be #14 AWG.		22
		23
Signal and control circuits other than mechanical shall be as indicated on Drawings or as required by equipment manufacturers.		25
		26
Conductors within approved fixture raceway shall be type RHH 90° C, except as noted otherwise on drawings.		28
		29
#10 AWG and smaller shall be solid copper, 98% conductivity, except for signal and control conductors.		31
		32
#8 AWG and larger shall be stranded copper, 98% conductivity.		34
All insulation shall be 600 volt rated minimum.		36
Insulation for the following types of circuits shall be type RHW with a neoprene jacket:		38
		39
Main Service feeders.		41
Emergency Engine feeders.		43
All conductors larger than 250 MCM.		45
Insulation for the following types of circuits shall be type THW when used for voltages 480 volt or less and for sizes 250 MCM and smaller:		47
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Distribution, panel and equipment feeders.		50
Motor control center feeders.		52
Branch circuits from panels, control centers and equipment cabinets.		54
Control circuit wiring (#12 AWG and larger).		56

Insulation for bonding and grounding conductors shall be type TW except as noted on Drawings.

Control wiring smaller than #12 AWG shall be type TFF.

Phasing: terminals in panelboards, motor control centers, switchboards, and other equipment shall be phased A,B,C, reading left to right or top to bottom looking into the front of the equipment.

Conductors shall be coded as follows:

<u>Voltage</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>	<u>Neutral</u>	<u>Ground</u>
120/208V	Black	Red	Blue	White	Green
120/240V	Black	Red	Blue	White	Green
265/460V	Orange	Yellow	Brown	Gray	Green

Direct current - positive is red, negative is black.

Control conductors, other than branch circuits, shall be black.

Connections to terminals shall be as follows:

Use lugs or socket type terminals furnished with equipment.

For #10 and smaller, T&B Sta-Kon, Buchanan "Termend" or equal, self insulated forked tongue lug.

#8 to #4/0 - single Hex head screw or bolt clamp type with double hole tongue, T&B locktite or Burndy Qiklug type QA. Lugs for paralleling circuits shall provide multiple clamping elements with single tongue.

#250 MCM and larger - double Hex head screw or bolt clamp type with double hole tongue, T&B locktite tandem or Burndy Qiklug type QQA.

Lugs for paralleling circuits shall provide multiple clamping elements with single tongue.

Splices:

#10 and smaller, including fixture taps - pre-insulated spring type connectors, 3M Scotchloks, T&B Piggys or equal.

#8 to #4, Split bolt service connectors, T&B locktite, Burndy Servit or equal, insulated with Scotch #88 or Okoweld four purpose tape.

#2 and larger, split bolt service connectors, OZ ST, Burndy OKLIP or equal insulated with "Scotchfill" and Scotch #88 or Okoweld four purpose tape.

Splices in underground pull boxes or in other areas subject to moisture shall be provided with cast resin kits. Use Scotchlok sealing packs for wire size to #10 and Scotchlok kits for larger splices as recommended by 3M Co. All splices to be prepared as hereinbefore specified before resin kits are applied. Kits by Okonite, G.E., or equ., may be used:

Wire splicing devices shall be sized according to manufacturer's recommendations.

Conductors in panels, motor control centers, etc., shall be laced with T & B TY-RAP's.

Lubricant for conductor installation shall be powdered soapstone, Y-er EAS, Minerallac "Pull-In" compound or other U.L. approved lubricant. Flax-soap is not approved and not permitted on the job.

Signal Conductor shall be as hereinafter specified.

Arc-Proofing: All power feeder cables in pull boxes containing more than one feeder set shall be covered with arcproof and flameproof tape, similar to Irvington #7700.

Cable Identification: Non-ferrous identifying tags or pressure sensitive labels shall be securely fastened to all cables, feeders, and power circuits in pull boxes and manholes. Tags or labels shall be stamped or printed to correspond with markings on drawings or marked so that feeder or cable may be readily identified.

Conductor Identification: Each branch circuit, control and signal conductor shall be labeled with the circuit number or terminal number it is connected to. Use T&B vinyl or Brady mylar markers. Conductors shall be labeled at each panelboard, switchboard, control center, terminal cabinet, pull box, and at each point of utilization such as fixtures, motors, speakers, etc. Labeling shall correspond to control diagrams where applicable.

Cable Supports: Cable supports and boxes shall be installed for all vertical feeders in accordance with the Codes. Cable supports shall be of the split wedge type which clamp each individual conductor firmly and tightens due to weight of cable. For cables with a metallic sheath, a basket weave or approved equal type of support shall be provided.

* * * * *

SECTION 16C - ELECTRICAL SERVICE AND DISTRIBUTION EQUIPMENTRELATED DOCUMENTS

The requirements of Division 1 apply to all work specified hereunder.

DESCRIPTION OF WORK

This section includes the furnishing and installation of electrical service and distribution equipment as described herein and shown on the drawings. Related work is specified in Sections 16A; 16B.

GENERAL

See Section 16A for General Requirements and 16B.

MATERIALS AND EQUIPMENTWall Plates:

Public Areas: US #9 Polished bronze, Sierra Electric Co., Slater or eq. locations directed.

Non-Public Areas: US #32D Satin Stainless Steel, Sierra Elec. Co., Slater or equal, locations directed.

Weatherproof - Cast aluminum with gasket between box and plate and between plate and cover, Hubbell 5200 series, Slater 3780 Series or approved equal.

Surface: Zinc or cadmium plated steel.

Switches: Black, brown, grey and white as selected.

Wall: Sierra #5021, 2, 3, or 4 or Slater 72 Series.

Three (3) position momentary contact: Sierra #5120 or Slater 727-GR.

Three (3) position maintained contact: Sierra #5122, or Slater 760-GR.

Pilot Light: General Electric GE 4218-0 or GE 4219-0, Sierra or equal, mounted alongside switch with common 2 gang plate.

Low Voltage: As specified under Section 16B. Low voltage lighting control system.

Receptacles: Black, brown, grey and white as selected.

Duplex Wall: Sierra 1800G, Slater or approved equal.

Duplex Surface: Sierra 1400G, Slater or approved equal.

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<u>Single Wall:</u> Sierra 1200G, Slater or approved equal.	5
<u>Clock:</u> Sierra 2122G, Slater or approved equal.	7
<u>Special Devices:</u> Refer to Drawings.	9
<u>Time Switches and Photo Controls:</u> Shall be as shown on Drawings.	11
<u>Panelboards and Switchboard:</u> Shall be Westinghouse, Ite Co., or approved equal, of type and arrangement as indicated on Drawings.	13
Layout of equipment on Drawings is based on Westinghouse Co.	14
	15
<u>Manual Motor Starters:</u> Square "D" Class 2510, Westinghouse or equal, with pilot light.	17
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<u>Fuses:</u> Shall be current-limiting non-renewable type with an interrupting rating not less than 100,000 amperes, and as indicated on the Drawings.	19
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	21
<u>Contactors and Relays:</u> Shall be Square "D" and Asco as indicated on Drawings.	23
	24
<u>Disconnect Switches:</u>	26
<u>For 208 Volt and 460 Volt Equipment:</u> Westinghouse, Ite Co., or approved equal, non-fused safety switches, general duty for 208 volt and heavy duty for 460 volt. Furnish with enclosure suitable for application.	28
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<u>For 120 Volt Equipment:</u> Westinghouse, Ite Co., or approved equal, horsepower rated toggle switches with suitable enclosure.	33
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<u>Motor Control Centers:</u> Westinghouse Type W, Ite Co., or approved equal, of arrangement as shown on Drawings.	36
	37
<u>General:</u> Control Centers shall be NEMA Class 1, Type B, general purpose enclosures.	39
	40
Cabinet dimensions of 90 inches high x 20 inches deep x 20 inches wide are maximum allowable.	42
	43
All major components of Control Center shall be of same manufacturer.	45
All load and control wiring shall be by plug-in type terminal blocks.	47
Bussing shall be as shown on Drawings.	49
<u>Combination Motor Starters:</u> Drawout type full-voltage non-reversing starters, Westinghouse Lifeline, or approved equal, with bi-metallic overload heaters for each phase conductor, temperature compensated.	51
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Circuit breakers shall be of the adjustable magnetic trip only type, Westinghouse MCP, or approved equal.	55
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Pilot lights, control power transformers, selector switches, push-buttons and the like shall be provided as shown on Drawings.	5 6
<u>Associated 4 pole relay shown on starter diagram shall be considered as part of starter.</u>	8 9
Relay contacts are for interlocking and indicating requirements. No foreign circuits shall enter starter compartment. Relays shall be grouped and mounted in an adjacent cabinet.	11 12 13
<u>General Requirements for Switchboards, Panel boards, Control Centers, Switch Cabinets, Etc.:</u>	15 16
<u>All switching devices shall have factory installed padlocking means.</u>	18
<u>Multiple pole circuit breakers shall have internal common trip connection.</u>	20
Single pole breakers shall not be tied at handles to form multiple pole breaker.	22 23
<u>Busses shall be copper with current density of 1000 amps. per square inch, maximum.</u>	25 26
Contact faces shall be silver plated.	28
<u>Interiors shall be finished with white enamel.</u>	30
<u>Surface mounted enclosures shall be finished to match trim.</u>	32
<u>Semi-recessed enclosures shall be fitted with a wood or metal escutcheon providing neat return to wall finish, flush with edge of trim.</u>	34 35
<u>Wall mounted enclosures shall be mounted with top of cabinet 6'-6" above finished floor, except as otherwise noted.</u>	40 41
<u>Enclosures, doors and trim, shall be finished in USAS 61 or standard factory gray enamel.</u>	43 44
<u>Switchboards, panelboards and control center enclosures shall be fitted with copper ground bus, similar to neutral bus, not insulated from enclosure. Bus shall be complete with lugs.</u>	46 47 48
<u>Conduits shall enter enclosure through neat hole and perpendicular to entrance face.</u>	50 51
<u>Directories shall be typewritten and conform to circuit assignment at time of occupancy.</u>	53 54
<u>Conductors shall be neatly laced with T & B Ty-Raps.</u>	56

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<u>Operating Manuals</u> shall be provided for switchgear and components.	5
<u>Nameplates</u> shall be as hereinbefore specified.	7
<u>Recessed enclosures</u> shall be provided with a minimum of 3'-3/4" empty conduits stubbed into accessible space. Drawings may require additional conduits.	9 10 11
<u>Busses</u> shall extend full length of usable space of distribution selections.	13 14
<u>LIGHTING DIMMERS</u> (As shown on drawings and specified in other Sections.)	16
<u>TRANSFORMERS</u>	18
Westinghouse Type DT-3 or G.E. Type H with voltage and power ratings as shown on Drawings, Complete with mounting brackets as required. Connect with flexible conduit. Verify exact location in field with Architect.	20 21 22
Provide taps 4-2 1/2% FCBN & 2-2 1/2% AN.	23
<u>Terminal & Control Equipment Cabinets:</u>	24
Shall be of panelboard type construction and finish.	25
Trim shall be fitted with hinged door and flush latch.	27
Doors shall provide maximum size openings to cabinet interior.	29
Signal and telephone shall be provided with 5/8 inch backboard having a two-coat insulating varnish finish.	31 32
Top of cabinet shall be 6'-6" above finished floor.	34
Control equipment cabinets shall be provided with suitable barriers to isolate devices in accordance with Codes.	36 37
<u>Buzzers, Bells and Associated equipment</u> shall be as indicated on drawings.	39
<u>Motor Starters</u> - Square "D", Class 8536, Westinghouse Life-Line or approved equal. (Separately mounted.)	41 42
Temperature compensated overload heaters in each phase conductor.	44
Overload heaters shall be sized according to motor actually installed.	46
Full load motor currents shall be tested and recorded after equipment adjustment has been made. Tabulated test results shall be delivered to Engineer prior to final inspection.	48 49 50
Magnetic starters shall be fitted with hand-off-automatic switch, red running pilot light and auxiliary "a" and "b" contacts necessary for any interlocking requirements. Control power is 120V.	52 53 54

Lighting Fixtures: Furnish and install fixtures as indicated on drawings, including lamps, hangers, frames, supports, etc., complete and ready for operation.

Fixtures, lamps, trim and diffusers shall be clean at final acceptance.

Fixtures mounted against combustible material shall be approved for such installation.

Ceiling spacers shall not be used when fixtures are not approved for mounting against combustible material. Material upon which fixtures are mounted shall be of incombustible type and arrangement satisfactory to Architect.

Recessed fixtures installed in fire rated ceiling shall have housing approved by the State Fire Marshal. Housing shall be provided by this contractor unless specified elsewhere.

Fluorescent fixtures shall be equipped with ballast having internally mounted automatic reset thermal protectors listed by U.L. as Class P, CBM approved and silver plated sockets.

Mercury vapor and metallic vapor fixtures shall be equipped with ballasts of the constant wattage, high power factor type with internally mounted line fuses.

Fluorescent fixtures with exposed lamps shall be fitted with lamp holders.

Ballast voltage shall be verified with branch circuiting requirements.

Fixtures shall be lamped with Sylvania, G.E. or equal lamps. All lamps of each type shall be of same manufacturer.

Fixtures installed at suspended ceilings, both surface and recessed fluorescent up to 24" wide, shall be supported with a minimum of 2 No. 12 G.I. wires. Fluorescent fixtures wider than 24" shall be supported with a minimum of 4 No. 12 G.I. wires. Fluorescent fixtures pendant mounted from suspended ceilings shall have their outlets and anchors supported by rods or strut assemblies. All such hanger wires, rods, and struts shall be supported from structural members and shall be attached direct to fixture. Fixture support methods shall be approved by Architect. Contractor shall submit detail of proposed methods of support for approval at time of fixture submittal. All supports for fixtures shall be provided by this contractor.

Accessories such as straps, mounting plates, nipples or brackets shall be provided for proper installation.

Bus Ducts: Shall be Square "D" 1-line, Westinghouse or equal, copper complete with elbows, offsets, connection boxes, transformer tap openings, wall flanges, flanges, hangers, etc., to form complete systems coordinated with power equipment and apparatus and with structural requirements. Ducts shall be silver plated at contact surfaces.

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Ducts shall be three phase half neutral of rating as indicated on drawings.

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Duct shall be weather proof.

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Ducts shall be braced for 125,000 Amps symmetrical minimum.

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Supports shall be spaced not more than 5 feet apart with at least one support at each elbow, bend, offset, tee, cross, etc. Drawings may require closer spacing in certain areas.

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Bus duct housings shall be insulated from ground at all points of support and attachment except where connected to main switchboard housing.

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Expansion joints shall be provided when required or recommended by manufacturer.

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Connections to switchboards, circuit breakers, etc., shall be of the bolted type.

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The two service sections and tie switch section shall be installed insulated from ground, other switchboard sections and all conduit and raceway connections exclusive of service bus duct housing. Submittals shall show in detail proposed methods of insulating switchboard mounting and raceway connections.

Housing of Service bus duct shall be bonded to switchboard housing using Burndy BGL2 flexible copper braid in addition to duct flange connections.

Instrument CT and ground fault relay to initiate tripping of SMUD network protectors shall be provided. Relay shall provide for ground current adjustable 100 to 1000 Amps with time delay adjustable instantaneous to 40 cycles. Sensor shall monitor ground current flowing between service section bonding bus and equipment ground bus. CT and relay shall be located at rear of one of the service sections accessible from rear.

Access covers shall be hinged, fitted with captive fasteners and labeled with Red-White engraved nameplates "460 volts -- Keep Out."

Shipping splits shall be such that sections can be moved into and out of completed building.

Service sections shall be arranged to comply with SMUD instrumentation requirements.

Switches, controls, devices and arrangement to comply with State of California, Division of Industrial Safety.

Switchboard shall be assembled in factory and shall undergo standard production tests as covered in NEMA Standards SG3, latest edition.

Flange sections of bus duct entrances shall be received from bus duct manufacturer and physically installed on switchgear in the factory, disassembled and shipped to project with the switchgear.

A qualified Service Engineer of the Switchgear Manufacturer shall provide technical assistance for installation of switchgear and components, inspect installation prior to testing and supervise testing. All bolts shall be tightened to proper torque, shipping blocks and ties removed, contacts adjusted, insulation resistance tested, and all components and complete assembly shall be in first class condition.

Each Service shall be provided with

One ammeter, 0-4000 Amps with associated instrument transformers and three phase selector switch.

One voltmeter, 0-500 volts with associated instrument transformers and three phase selector switch.

Test blocks for attachment of recording ammeters and voltmeters.

Ground fault sensor and relay to trip main switch. Sensor shall monitor

main bus on load side of respective main switch. Sensors shall be adjustable 100 to 1000 Amps with time delay adjustable instantaneous to 40 Cycles.

Relay output shall operate from a 120V AC source obtained through a control power transformer. All equipment shall be mounted within switchgear with ground relay arranged for flush mounting in instrument section with visible target indicator. Provide red light with push to test mounted adjacent to ground relay which will be energized whenever ground relay has acted to cause main switch to open. This indicating light shall not be energized if main switch has opened because of manual or other automatic operation.

Main switches shall be of the bolted pressure load break type, rated 4000 Ampere 480 volt with interrupting capacity 200,000 Amperes RMS symmetrical with NEMA Class L fuse accommodations, electrically operated (on opening only) as manufactured by Pringle Co., or approved equal. Each main switch shall be kirk-key interlocked with tie switch to prevent both main switches being closed when tie switch is closed. Access to switch and fuse mechanism shall be interlocked to prevent access when switch is closed or when tie switch is closed.

Tie Switch shall be same as main switches except that no fuses or electrical operation is required. Access to switch mechanism shall be interlocked to prevent access when either one or both of the main switches is closed. Tie switch shall be kirk-key interlocked with each main switch to prevent tie switch being closed when both main switches are closed.

Circuit Breakers shall be as indicated, thermal magnetic with interchangeable trip unit and replaceable current limiter, and rated 100,000 Amperes symmetrical RMS. Breakers shall be bussed to main bus with bus fully rated to breaker frame capacity. Ground fault sensor and relays shall be provided for each breaker. Breaker for theatre switchboard does not require current limiters.

Sensors shall be adjustable 5 to 50 Amps with time delay adjustable instantaneous to 40 cycles. Sensors shall be placed around all phase and neutral conductors of respective feeder cables. Relay output shall operate from a 120 VAC source obtained through a control power transformer. Ground relays shall be flush mounted on rear access panel of respective distribution section with visible target indicator.

Fuses for main switches shall be NEMA Class L current-limiting 4000 Ampere. Provide one set of three spare fuses mounted in hinge cover cabinet located adjacent to switchboard.

Provide one set of three spare current limiters of each rating mounted in the spare fuse cabinet.

Provide two sets of spare control circuit fuses of each type and rating mounted in the spare fuse cabinet.

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SECTION 16D - GROUNDING SYSTEM

RELATED DOCUMENTS

The requirements of Division 1 apply to the work specified in this section.

DESCRIPTION OF WORK

This Section applies to all of Division 16. All conditions contained herein are pertinent to the other sections as if repeated in those sections.

Furnish and install all work and materials required to completely ground the electrical work in this project.

GENERAL

See Section 16A for Electrical General Requirements, also 16B, and 16C.

MATERIALS & INSTALLATION

Grounding Electrodes: Foundation ground grid shall consist of #4/0 soft drawn bare copper conductors installed at bottom of foundation with 3-inches of concrete between conductors and earth, encased in concrete their entire length exclusive of tails for connections to main ground bar. Conductors shall be interconnected by the Cadwell process using molds and charges according to manufacturer's recommendations. Tails for connections to main ground bar shall provide not less than 24-inches length above finished floor. All tails shall be protected against damage. At the main ground bar install short vertical lengths of conduit with a bend at the bottom and a grounding bushing at top, approximately 8-inches above the floor, each enclosing one or more tails.

Group risers closely and coordinate with other grounding conductor risers to conserve terminal space on main ground bar.

Connect tails to the main ground bar with specified mechanical connectors.

Miscellaneous grounding electrodes, such as connections to building water mains, shall have insulated conductors run direct to main ground bar in conduit as shown, separate from any other grounding conductor.

Main Ground Bar: Shall be of standard electrolytic rolled copper bus bar of the size shown.

Insulating bus supports shall be used.

Use T & B "Locktite," two hole standard lugs, catalog number 32000 Series, Burndy or equal for all connections of cable to bus bar.

Bolts for bus supports or lugs shall be galvanized steel, hex head, of correct length with galvanized heavy cut round flat washers and galvanized spring lock washers.

Each conductor attached to ground bar shall be identified by means of an engraved or stamped brass plate attached to the conductor lug.

Seal conduits stubbed from slab at ground bar with approved sealing compound.

Grounding Conductors: Shall be Type TW or THW wire, with insulation colored white or white with black stripe for system neutral grounding or green for enclosure or raceway grounding, except that bare copper may be used where specifically noted herein.

All conductors shall be in raceway or approved enclosures. Following classes of grounding circuits shall be electrically isolated from each other everywhere except at the main ground bar:

460Y/265 Volt System "Service" Neutral Grounds: White with black stripe insulated conductor run in conduit.

Only one connection to the neutral of each separate system shall be made.

208Y/120 Volt System Neutral Grounds: White with black stripe insulated conductor run in conduit.

Raceway and Equipment Ground: Green insulated wire, run in conduit with circuit conductors where possible, in separate conduit where necessary. Bare copper wire used for bonding, only as described below.

Bonding: Run a code-sized green insulated bonding conductor from the separate ground bus in each switchboard, panelboard, or motor control center in each three phase circuit conduit, to the frame or enclosure of each three phase appliance, motor, transformer and the like. Connection to frame or enclosure shall be with specified mechanical lug, to a screw or bolt with lock washer used only for lug attachment, on a clean smooth bare metal surface.

Run a code-sized bonding conductor from the ground bus in each branch circuit panel or motor control center back through feeder conduit to the ground bus in the distribution panel containing the feeder breaker.

Run a code-sized green insulated bonding conductor from the ground bus in each distribution panel or motor control center supplied direct from a main service switchboard ground bus. Main service switchboard ground buses are connected directly to main ground bar.

At every main service switchboard, motor control center, transfer switch, control panel, or panelboard, all feeder conduit terminals shall be bonded to the ground bus with code-sized bare copper conductors, using the specified insulated grounding bushings. Each conductor shall be lugged separately to bus.

Where the raceway is used as the grounding conductor, good contact shall be made between conduit or tubing and panels, cabinets, boxes and equipment, lighting fixtures, etc., to maintain continuity of ground. Where it is not possible to obtain good contact, additional bonding shall be provided.

Supplemental bonding shall be provided between raceway and enclosure and at concentric knockouts and at reducing washers.

All non-metallic raceways exclusive of telephone and signal shall contain a code-size copper conductor, green insulated, properly bonded to equipment at either end and to metallic portions of the same raceway.

All grounding type receptacles shall have grounding contact connected to a grounding conductor. Grounding conductor may be code-size green insulated copper conductor installed in circuit raceway or may be metallic raceway. If metallic raceway is used as grounding conductor, a green insulated copper conductor must connect receptacle grounding contact to lug or screw terminal in outlet box or to grounding bushing at raceway.

Provide bonding jumper around flexible metallic conduit. Bonding jumper shall be inside flex.

Raceway size shall be increased if necessary to accommodate bonding or grounding conductors and shall be based on raceway fill tables.

Where cabinets are furnished with grounding bus all required bonding conductors shall connect thereto, each with separate lug.

SECTION 16E - LOW VOLTAGE CONTROLRELATED DOCUMENTS

The requirements of Division 1 apply to the work specified in this section.

DESCRIPTION OF WORK

This section includes the furnishing and installation of complete low voltage systems and equipment for control of circuits as described herein and shown on the drawings.

GENERAL

See Section 16A for Electrical General Requirements.

See also Sections 16B and 16C.

MATERIALS AND EQUIPMENT

Equipment shall be General Electric "Remote Control", Sierra Elec. Co., or approved equal. Transformers, rectifiers and associated relays shall be installed in barriered component cabinets mounted as indicated on Drawings.

Switches, relays and transformers shall be provided to accomplish switching control indicated on the plan. Number and size of cable shall be as required for the system installed. System shall be installed per manufacturer's published printed instructions.

Equipment shall be as follows: (Numbers refer to G.E. Company)

Relays: RR7 or RR8, standard type rated 20 amp at 120V AC or 277V AC as applicable, splitcoil design operating on 24 volt switch circuits.

Control Switches: RCS2PL Pilot Light 25V AC SPDT N.O. momentary-contact, flush mounting, grey or as selected by Architect.

Transformers: RT1 and RT2 in single or parallel operation as required by circuit conditions.

Master Selector Switch: RMC2PL 12 position push button.

Rectifier: RA16.

Control Cable: #53083-3, #53088-12, as required for control function.

Component Cabinet: RBF3, RBS1 or BRS2 with steel separator, terminal blocks and hinged captive fastener cover.

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SECTION 16F - UNDERFLOOR RACEWAY SYSTEMS

5

RELATED DOCUMENTS

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The requirements of Division 1 apply to the work specified in this section.

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DESCRIPTION OF WORK

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This section includes the furnishing and complete installation of the underfloor raceway systems as described herein and shown on the drawings.

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GENERAL

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Duct Fittings: Duct supports for each duct shall be located as close as practicable to all duct joints, elbows, bends and terminations, with 30-inches on each side of each junction box, and elsewhere at intervals of not over 5 feet.

All joints shall be suitably tight to prevent entry of concrete or fill during pours.

Junction Boxes, Fittings: The conduit extensions from the underfloor duct junction boxes or trench ducts where shown shall be run below the duct wherever it is necessary to cross a duct run, or shall be run in the furred ceiling below. The conduit extension shall enter junction boxes at corner or bottom openings, or at spare duct openings through duct adapters.

Junction boxes in finished areas shall be supplied with recessed cover plates. These covers shall be filled with the required floor surface. Plates and rings shall be protected from damage at all times, especially during the placing of concrete or floor fill. Junction boxes and trench ducts shall be protected against entry of concrete and against injury or distortion.

Junction boxes shall be installed on a concrete pad of suitable area and height, or they shall be supported by heavy screws.

Closure Plates or Plugs: Unused entrances to junction boxes or any terminal ends of ducts shall be closed with blank closure plates or plugs.

Inserts: Inserts shall be provided on 24-inch centers over the entire length of each duct. Exceptions to the above are for connecting ducts between parallel ducts less than 6 feet apart (center to center), and ducts located in permanent corridors, vestibules, passages and lobbies. Inserts shall be of the same manufacture as the underfloor duct. Inserts shall be aligned on the same centers for the various services and for duct rows in the bays. Inserts closest to junction boxes or trench ducts shall be not more than 12-inches from vertical faces of junction boxes or trench duct.

Openings for inserts in the duct shall be at least 2-inches iron pipe size for steel ducts.

Inserts shall be made of metal not less than 0.067-inch average uncoated thickness or 0.070-inch if zinc-coated and shall be of the same metal as the duct.

All necessary cutting of floor for the installation of service outlet fittings shall be made in a neat, workmanlike manner and as recommended by the duct manufacturer. The floor construction or finish damaged by the installation of fittings shall be patched or replaced as directed by the Architect.

Service Fittings: All active 120-volt service and other power receptacles and connections shall be completely wired and connected under the Contract at no additional cost to the Owner regardless of the selection of location required by the Architect.

Type of wire shall be as hereinbefore specified for branch circuits generally. Where branch circuiting is not explicitly designated, there shall be no more than eight 120-volt receptacle fittings connected to a single circuit. Sufficient slack wire shall be left in the junction boxes for future connection of intermediate outlets feeding from the same circuit. Splices and taps shall be made only at junction boxes.

Duct Markers: Suitable identifying corrosion resistant duct marker screws flush with finished floor shall be provided on each duct at the following locations:

At the end of duct not terminated by or in a junction box or trench duct, electric or telephone equipment closet or cabinet, at the closest inserts to any change in the direction of a duct where change in direction is not made at a junction box or trench duct.

Grounding: Where metallic duct is used, it shall be installed so that the continuity of the ground throughout the system is maintained.

SUBMITTALS

Shop Drawings: Complete layout of duct system and construction details, including list of miscellaneous items required.

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<u>SECTION 16G - FIRE ALARM SYSTEMS</u>	5
<u>RELATED DOCUMENTS</u>	7
The requirements of Division 1 apply to all work specified hereunder.	9
See Section 16B and 16C for related work.	12
<u>DESCRIPTION OF WORK</u>	14
This section includes the furnishing and installation of a complete fire alarm system as described herein and shown on the drawings.	16 17
<u>GENERAL</u>	19
See Section 16A for Electrical General Requirements.	21
<u>The system and all its components</u> shall meet the requirements for a local alarm system of Title 19, Chapter 1, Subchapter 1, Article 72, California Administrative Code; National Fire Protective Association Bulletin 72A. All equipment shall be UL listed and labeled.	23 24 25 26
<u>System Operation:</u> The system is comprised of three separate subsystems one for each of the Theater, Activity and Exhibit Buildings. Each subsystem is complete and independent of the others, zoned and supervised.	28 29 30
Actuation of any automatic detector or flow switch in a particular building shall:	32 33
1. Energize the Municipal Local Energy Control to trip city Master Box. (Note: Three city boxes will be provided by others; one for each building.)	35 36 37
2. Sound alarm signals in respective building.	38
3. Indicate the alarm zone on the respective building annunciator panel at Fire Sprinkler Riser Manifold.	40 41
4. Indicate the alarm zone on the respective building annunciator panel at Supervisor's office in Activities Building.	43 44
5. Sound alarm signal in Supervisor's office in Activities Building.	46
An open or ground on any alarm circuit in a particular building shall:	48 49
1. Activate trouble lamp and buzzer on the respective building Master Panel located in Activities Building.	51 52
2. Activate trouble lamp and buzzer on the respective building annunciator panel at Supervisor's office in Activities Building.	54 55
Failure of power supply to any Master Panel shall:	57

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1. Sound buzzer on the respective building Supervisory Panel at Activities Building.

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2. Sound buzzer and activate trouble lamp on the respective building annunciator panel in Supervisor's office in Activities Building.

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Each subsystem shall be electrically supervised against open circuits and grounds on the wiring to the alarm initiating devices.

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Panel shall supervise the alarm wiring for each zone for each of the subsystems.

Each subsystem section shall contain 10 alarm zone indicator lamps, red color; indicator lamps for system wiring trouble and power failure, amber color, with associated buzzers and silence switches; system reset switch, and provisions for activating alarm by key switch. Engraved lamacoid nameplates shall clearly describe each lamp and switch function and panel assignment.

Annunciator panels shall be Simplex type 4300, Edwards Co., or approved equal.

Annunciator Panels (Fire Sprinkler Riser Manifold, three total) shall be similar to those in Supervisor's office except that 10 alarm zone indicator lamps, amber color, only are required. Panel shall be for surface mounting finished ASA 61.

Municipal Local Energy Control Units (three total) shall be for surface mounting finished ASA 61 to operate the trip coil of the Municipal Local Energy Master boxes at fire sprinkler riser manifold.

Control units shall be provided with drill switch and pilot to permit testing of building systems and with trouble buzzer.

Units shall be Simplex type 4244-5, Edwards Co., or approved equal.

Power Supervisory Panels (three total) shall be for surface mounting in steel cabinet with hinged door secured by a lock. Panels shall provide an audible and visual alarm when power supply to associated Master Panel has been disrupted. Volt-meter, power failure flag, test button and relay, buzzer, silencing switch and trouble lamp to be provided. Units shall contain wet cell battery for alarm power supply, with charger panel adjustable for hi or lo charge on battery.

Panels shall be Simplex type 6580-2, Edwards Co., or approved equal.

INSTALLATION:

Electrical Contractor shall retain the services of the duly appointed representative of a nationally known concern engaged in the manufacture or distribution of equipment as specified above, who shall furnish all equipment, supervise all connections to same and place the system in operation.

The technician and workmen employed shall be particularly skilled in this type of work.

All cables entering a terminal cabinets shall be identified with Brady or E Z Code wire markers.

Each cable run on the wiring diagram shall be identified with the exact wire marker code (numerical or alphabetical) as appears in the terminal cabinets.

All system wiring shall be as indicated on plan. Wire shall be run in conduit, and as required by the manufacturer. The system shall test free from grounds, opens and short circuits.

Station Locations shall be identified by final room designations and in all ways the one-line wiring diagram shall relate as closely as possible to the architectural blueprints.

SUBMITTALS

Submit 6 copies of one line diagram and manufacturer's data of complete system showing all alarm stations, horns, cabinets, etc., and associated wiring.

SECTION 16H - STAGE LIGHTING CONTROL SYSTEMS

5

RELATED DOCUMENTS

7

The requirements of Division 1 apply to all work specified hereunder.
See also Sections 16A, 16B and 16C.

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DESCRIPTION OF WORK

11

All materials, components and services necessary to provide the systems and equipment indicated above as specified herein and shown on the drawings, so that when the contractor is finished, a fully working system will be turned over to the Owner. These include but are not limited to:

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Preparation and submission of shop drawings, wiring diagrams and material lists for approval prior to fabrication of the equipment.

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Verification of dimensions and conditions at job site.

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Installation in accordance with these specifications, pertinent drawings, established trade criteria and applicable code requirements.

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Inspection, necessary adjustment, demonstration and guarantee of completed installation.

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Furnishing of "as-built" shop drawings, wiring diagrams, material lists, service and operational data and certificates incorporated as part of the Operation and Maintenance Manual.

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Furnishing of certain equipment and components to others for their installation in other systems.

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Items Not in this Contract include the following:

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Principal supporting members for lighting fixtures such as grid irons, pipe battens, etc. -- except as herein specified.

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Certain sound system control equipment and components furnished by others for installation and wiring under this Section.

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GENERAL

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A. Intent: The intent of this specification is to establish requirements for furnishing, installing, testing and placing in operation, the necessary equipment and appurtenances for control of stage and platform lighting equipment and certain related systems.

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B. Responsibility: To assure a uniform installation and single responsibility, all the equipment including fixtures, connector strips, plugging boxes, floor pockets and wall pockets, and the lighting control systems shall be the product of one manufacturer.

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This manufacturer shall be one who has been continuously engaged in the production of theatrical lighting and control equipment for at least ten years and shall have been engaged in the manufacture of SCR control systems and dimmers for five years or more. Contractor shall engage the services of manufacturer as indicated below.

C. Codes: All lighting instruments and items of equipment, and individual components where applicable standards have been established shall be listed by Underwriter's Laboratories, Inc., and shall bear the UL label when delivered and installed on the job. Special attention is called to NEC section 520.

D. Materials and Equipment: In order to indicate the quality and functional performance required of the system and its components, certain items of equipment are specified herein by manufacturer's type numbers. The stage lighting and control equipment specified is called out in terms of products as manufactured by Kliegl Bros. Substitute proposals embodying equal or superior equipment of Strand Co., Ward-Leonard Co., or Hub Co., will be welcome, subject to compliance with these specifications. Such proposals must be accompanied by sufficient catalog data, specifications, and technical information to enable the Architect to evaluate them. Should first submittal for proposed substitution be rejected, the Contractor shall furnish Kliegl Bros.

All material finished and colors and the appearance of all equipment shall be subject to the approval of the Architect.

E. Manufacturer's Services: The manufacturer of the lighting control system shall arrange to have an engineering representative on the job to instruct installer. After installation has been completed and prior to energization of the system, manufacturer shall test and adjust the system and direct the installer for corrections. Manufacturer shall demonstrate and instruct Owner's representatives in operation and maintenance of the system as hereinbefore specified.

Provide two year guarantee, warrantee and service contract.

MATERIALS

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A. Stage and House Equipment:

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1. Master Lighting Control Console: The master lighting control console shall be free standing, floor supported, substantially framed and enclosed with sheet metal panels housing control equipment for stage and House lighting circuits. Access to interior wiring and components shall be provided by hinged doors having locking latches. Equipment and device arrangement shall be as indicated. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the console with each terminal clearly and permanently identified by circuit or wire number. All interior wiring shall be done at factory suitably laced and bound. It shall only be necessary for contractor to connect incoming field wiring to terminals provided.

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Control console shall perform the following functions:

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Individual switching and/or dimming control of dimming and non-dim circuits.

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Group switching and/or dimming control of any group of dimming and non-dim circuits.

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Pre-setting of any or all dimming circuits in advance without changing or affecting the setting or intensity of any circuits in operation.

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Switch operation or cross fade from one group of pre-set intensities to another.

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Slide on one group of pre-set intensities to another group of pre-set intensities.

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Simultaneous brightening or dimming of groups of circuits while maintaining their relative pre-set intensities (proportional dimming).

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Equipment and arrangement shall include the following:

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- a. Lock and Key Switches shall be provided to allow energization and de-energization of the dimming system. A pilot light shall be provided to indicate "on" position of switch. Switch shall provide interlocking feature to prevent all other Stage and House lighting control points from functioning when master control console is activated.
- b. Console Work Light: Provide console and instrument lights for the console, so designed to illuminate the surface of the console evenly while at the same time, confining the illumination to the operating sections of the console. Provide separate dimming control over intensity of console and instrument lights with separate fuse protection.

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- c. Convenience Outlet: A 20 Ampere 120 volt duplex convenience outlet shall be provided. 5
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- d. Overload Protection: Overload and short circuit protection required shall be grouped and labeled for convenient access by the operator. 8
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Use indicating fuse holders.
- e. Cue Sheet Holder: Provide one cue sheet holder. 12
- f. House Lighting Controls: Provide controls for house lighting as follows: 14
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- 1) One (1) main lock and key switch control and pilot light. 17
 - 2) One (1) panic system control and pilot light push button with raised ring. 19
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 - 3) Six (6) sub-master dimmer control potentiometers each with integral 3-position switch independent-off-master. 22
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 - 4) One (1) 3-position center return momentary contact toggle switch for motorized master control potentiometer. 25
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 - 5) One (1) toggle switch for black-out control. 28
- g. Non-Dim Control: Provide 6 3-position on-off master switches for non-dim circuit control plus master. 29
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- h. Worklight Control: Provide four 3-position, momentary contact, center off switches for rehearsal/worklight control. Provide pilot light with each switch to indicate relay "on". 31
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- i. Stage Lighting Controls: Provide controls for stage lighting as follows: 34
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- 1) Main lock and key switch control with pilot light. 36
 - 2) Grand master control potentiometer with integral on-off black out switch. 38
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 - 3) Split fader mechanism with black out switches and pilot lights. 41
 - 4) Manual master potentiometer with integral on-off black out switch. 43
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 - 5) Multi-scene selector push buttons, two per scene for total of six. 46
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 - 6) Submaster control potentiometers with integral on-off black out switch, six per scene for total of 18. 49
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 - 7) Mode selector switches three position, preset-off-manual, total of 66. 52
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 - 8) Diode pin matrix panel, 18 x 66 with 20% spare pins. 55
 - 9) Dimmer controller potentiometers, 66 per each of three preset scenes for total of 198. 57
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10) Operating components shall be mounted within engraved, hard anodized sealed aluminum panels. Complete accessibility to interior components shall be provided through locking hinged access panels. Terminal strips of adequate rating shall be provided for all connections to the console with each terminal clearly and permanently identified by circuit or wire number. All interior wiring shall be done at factory, suitably laced and bound. It shall only be necessary for contractor to connect remote field wiring to terminal blocks provided. Rear access shall not be required for installation or maintenance. Finish shall be baked enamel, color as selected. All components containing moving parts shall either be of the plug-in type, or mounted on removable panels so that access for maintenance is simplified.

j. Dimmer Controller Potentiometers (without integral on-off switch): Each individual potentiometer shall be of the plug-in type molded of unbreakable polycarbonate self-color, terminating in male pins plugging into a master bus bar. All potentiometers shall be easily removable and completely interchangeable. Each control potentiometer shall be capable of finger tip rectilinear operation. There shall be direct drive from finger tip to the wire-wound resistance element. The scale shall be approximately 3 inches in length and have a "zero" position, "off" position, a "10" position, and in-between numbers "1" through "9" with half marks. When controller is at "off" position, output voltage at dimmer should be zero. Scale selection positions shall be rear illuminated (edgelit) by an internal extended-life lamp. Lamp shall have easy access for maintenance. Potentiometer shall be a $\pm 5\%$ 10K ohm precision controller with a $\pm 2\%$ conformity. Control output shall be linear and produce a square law curve at the dimmer output. Individual potentiometers which differ in curve and scale shall not be acceptable.

The color of potentiometer and knob shall be as shown on drawings. Circuit identification shall be by engraved plastic plate permanently affixed to potentiometer.

k. Sub-Master Potentiometer with Integral Switch: The plug-in sub-master potentiometer shall be of a design identical to individual potentiometers. Integral switch shall be two position on-off.

The sub-master controller shall control a solid state amplifier. This amplifier shall be a plug-in unit for ease of maintenance. The sub-master control shall be capable of mastering from one channel to the maximum number of assignable channels with less than 0.5 volt regulation regardless of loading. Sub-master control amplifier shall produce a control voltage which is linearly proportional at all points in the control system.

Only sub-master units which are thus unaffected by the quantity of assigned control channels and which have linear output will be acceptable.

Color of potentiometer and switch knobs shall be as shown on drawings.

- l. Master Potentiometer with Integral Switch: The plug-in master potentiometer shall be of a design identical to individual potentiometers. Integral switch shall be two position on-off.

The master controller shall control a solid state amplifier. This amplifier shall be a plug-in unit for ease of maintenance. The master control shall be capable of mastering from one channel to the maximum number of assignable channels with less than 0.5 volt regulation regardless of loading. Master control amplifier shall produce a control voltage which is linearly proportional at all points in the control system.

Only master units which are thus unaffected by the quantity of assigned control channels and which have linear output will be acceptable.

The color of the potentiometer and switch knobs shall be as shown on Drawings.

- m. Multi-Scene Selector System: Provide a two-button Alternate Action Rear Illuminated Selection System for "off" and each scene in the multi-scene preset panel. This system will assign the control of scenes (groups of preset potentiometers) to a selected master fader control. Depressing the right button (Y) will place the control of the selected scene on the right side (Y) of the master fader. Depressing the left button (X) will place the control of the selected scene on the left side (X) of the master fader.

- n. Split-Fader System: Solid-state electronic fader complete with switches and pilot lights shall perform the following functions:

Fade directly from one scene to another with a single action of the control handles (one hand operation) without mechanical linkage between the two control handles.

Operate either of the fader control levers independently or jointly.

Fade in or out of desired scenes completely or partially, as desired.

Change individual scene fade in or out time at the will of the operator by being able to fade one scene faster or slower than the next one.

This fader mechanism shall have handles which move through an arc with a minimum travel of 70 degrees. The scale shall have an "off" position, a "zero" position and a "10" position with in between numbers "1" through "9" with half marks. The fader potentiometers shall master their scene controllers through a plug-in solid state electronic time variable amplifier. This amplifier and its regulated power supply shall accomplish the following:

Fading from scene to scene without dip. There shall be no perceptible dip between equally set potentiometers in the scenes being faded.

Accept variations of load from one dimmer controller to the total number of assignable controllers in the system with a maximum variation at any setting of 0.5 volts regardless of load.

Regulation shall be plus or minus 1.0% although voltage input to console may fluctuate plus or minus 10V. With normal input 120 vac. there shall be less than plus or minus 1.0% regulation from 110 vac. to 130 vac. input.

Produce control voltage that is linearly proportional at all points in the control system.

Maintain outputs whose peak voltages (measured by an oscilloscope) do not exceed 60 volts (120 vac. input to console).

Only fader units which exhibit these characteristics of linearity, regulation and lack of dip will be acceptable.

o. Matrix Panel: Preset interconnection matrix shall be of 1/4" lattice type, arranged with three groups of six horizontal rows interconnected to sixty-six vertical columns.

Selection and assignment of potentiometer controllers to submasters in the preset system shall be by means of electrically conducting, easily inserted "pegs," each containing blocking diodes within an insulated handle. Interconnecting devices are to be arranged and circuited in such a manner that connection or disconnection of any potentiometer to any submaster has no effect on any other element of the system and has no effect on the output level of the specific submaster involved in the switching. Matrix shall be recessed behind locking, 1/8" thick, clear plexiglas panel. Pin layout must be visible to operator through plexiglas.

2. Dimmer Banks:

a. General: The dimmer banks shall be designed to operate at 120/208 Volt three phase four wire 60 Hz.

Banks shall be free standing, floor supported, dead front, dead rear, substantially framed and enclosed with sheet metal panels. Each section shall be provided with full size hinged door having cabinet locking handle. Access to interior of banks for installation and maintenance shall be from front of bank only. Equipment and device arrangement shall be as shown on the drawings. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the banks with each terminal clearly and permanently identified by circuit or wire number. All interior wiring shall be done at factory, suitably laced and bound. It shall only be necessary for Contractor to connect incoming field wiring to terminals provided.

All equipment necessary for the operation of the banks under the intent of these specifications shall be provided with overload and short circuit protection. Electrical system serving dimmer banks will limit available short circuit current to maximum of 5000 Amps Symmetrical RMS. All circuit

breakers shall be fully magnetic. Entire dimmer bank shall bear UL label.

Main section of each dimmer bank shall contain necessary lugs for incoming feeder cables, circuit breakers and control devices as shown on the drawings. Suitable barriers, interlocking control, overload protection and disconnects shall be provided as required by applicable codes and system operation.

- b. Dimmer Racks shall be of modular design incorporating horizontal and vertical rails for receiving dimmers. Connectors for dimmers and all required wiring shall be provided. Each rack shall be provided with quiet running fan or blower for forced air ventilation. Intake air shall be dust-filtered. Filter location and cleaning instructions to be indicated by engraved panel on front of rack.

- c. Dimmers: The dimmers shall be completely self-contained of "plug-in" design with chassis guide tracks to assure positive connector alignment. Power and control connections to be by male multi-pin connectors on the chassis and fixed mating females within the rack. Each dimmer shall be contained within heavy gauge steel framing of open design with a substantial pull handle at front. Installation or removal from rack shall be without the use of tools. Dimmers shall be U.L. listed and labeled.

The dimmer face plate shall contain the dimmer primary circuit breaker and a pilot light to indicate operative status of the dimmer. The following dimmer curve adjustment controls shall be accessible through the face plate of the dimmer, without having to remove the dimmer from the rack:

Minimum or Bias	(Lower portion of dimming curve)
Voltage Regulation	(Middle portion of curve)
Current Limiting	(Maximum current)

A standard Cinch-Jones test socket shall be provided in the dimmer face-plate for test and adjustment of the dimmer input, output and control circuits, current sensing coils and ground. When used with the proper test equipment, the dimmers may be operated and adjusted independently of the control console without removing the dimmer from its normal position.

With the exception of the circuit breaker and the adjustment controls indicated above, the dimmer shall not contain any moving parts whatsoever.

- 1) Identification: Each dimmer shall be plainly identified in an approved manner with the manufacturer's name and address, dimmer rating in amperes and volts, control circuit requirements and catalog identification to meet listing and code requirements. Dimmers shall each bear an individual serialized number for identification.

- 2) Dimmers must conform to following criteria:

- a) Input: 120 volts 50/60 Hz.

4) Output:

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a) Power: Full rated capacity, indefinitely.

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b) Wave Form: AC only, approaching sine wave symmetrical with respect to zero voltage axis and current axis. There shall be no DC introduced in the line.

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c) Regulation: Plus or minus 2-1/2% regulation from minimum to full rated load at any point on dimming curve.

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d) Dimming Curve: Not more than 3% variation from standard square law curve.

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e) Hysteresis Effect: Output to repeat whether controller is moved up or down.

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f) Stability: No variation except when the controller is moved. No drift.

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g) Variance: Not more than 3 volts RMS output difference on changing between any controller and another and any master and submaster controllers.

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5) Overload Protection: The dimmer shall incorporate a current-sensing device which will keep the output current of the dimmer at a safe level at any load, and whether or not the dimmer is loaded in excess of its rated capacity. The maximum output current shall be limited to rating plus five amperes or 10% whichever is less, continuously through 300% overload. Current limiting shall not affect dimmers operating at rated load or less. The dimmer shall continue to operate even with loads substantially in excess of the rated capacity; however, such operation shall automatically be at reduced voltage and within the current rating of the rectifiers employed. Dimmers with current limiting fuses are not acceptable. Provide dimmer protection from load short circuit.

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6) Protection during Plug-In: Replacing and re-arrangement of the dimmers, whether partially or fully loaded, shall be possible without first tripping the circuit breaker and without harming the rectifiers or causing scoring, arcing or pitting of the dimmer contacts.

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7) Effects of Primary Energization: It shall be possible at all times to energize any primary disconnect such as the main breaker or the dimmer primary circuit breaker regardless of the setting or loading of the dimmers without affecting the rectifiers in any way or tripping the dimmers' protective circuit breaker or causing flash-over.

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8) Thermal Characteristics: Dimmers shall be designed to operate within a normal ambient temperature range of 0°C. to 40°C. and in normal relative humidities of 20% to 90% with no adverse effects from thermal cycling within these ranges.

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9) Testing: All dimmers are to be factory tested prior to shipping. Submit

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certified test data by independent testing laboratory attesting to compliance with the above requirements and indicating test procedures and test equipment.

d. Test Kit: Provide a portable test kit for testing and adjustment of the dimmer output, output and control circuits, current sensing coils and ground. Kit shall permit dimmers to be operated and adjusted independently of the control console without removing the dimmer from its normal position in the bank. Kit shall include all instruments, controls, cords, plugs, and be housed in a sturdy suitcase type carrying case.

e. Stage Lighting Dimmer Bank shall be as specified above including the following particular features:

- 1) Main busses of copper bar sized to a minimum of 1000 Amps per phase and neutral.
- 2) Ground bus of copper bar 1/4" x 2" to run continuous the full length of bank.
- 3) Circuit breakers and mercury contactors for non-dim circuits.
- 4) Circuit breakers and low voltage latching relays for rehearsal/worklight circuits.

f. House Lighting Dimmer Bank shall be as specified above including the following particular features:

- 1) Main busses of copper bar sized to a minimum of 300 Amps per phase and neutral.
- 2) Ground bus of copper bar 1/4" x 2" to run continuous the full length of board.
- 3) Main circuit breaker 300 Amp, 3 pole with 120 volt shunt trip coil for remote operation. Include overload and short circuit protection for shunt trip circuit.
- 4) Branch circuit breakers for house lighting circuits.
- 5) Relays for panic button operation to turn on all house lighting circuits.

3. Cross Connect Panel: The cross-connect panel shall be of the hot patch free standing, floor supported type with counter-weighted cord and plug sets arranged in rows on overhead angled 1/8" anodized aluminum plates with female receptacles arranged on vertical 3/8" bakelite plates in front of the operator. Aluminum plates shall be engraved before anodizing and engraving filled after anodizing. Equipment and device arrangement shall be as shown on drawings. Dimensions shall not exceed those shown.

The cross-connect system shall be of the "Hot-patch" cord and plug type UL listed and labeled designed to provide for:

- Complete dead entry interconnection of any lighting circuit with any dimmer or non-dim circuit of the corresponding rating.

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| - Secondary circuit breaker protection for lighting circuits. | 2 |
| - Connecting a male plug into a female receptacle without the receptacle first being de-energized. | 5 |
| - Disconnecting a plug from a female receptacle without the receptacle first being de-energized. | 7 |
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Disconnecting and disconnection may be made at any time during the

The panel shall have quantity of female receptacles, grouped and rated at the ampacity indicated on the drawings. Each receptacle shall be of the split-pin type. Each group of receptacles shall have an engraved number indicating the number of the dimmer or non-dim circuit represented.

Each load circuit shall be protected by a single pole, fully magnetic circuit breaker. Layout and ratings of breakers shall be as shown on the drawings.

Provide a full length fluorescent board light overhead with dimmer control over intensity and integral push type on-off switch.

Provide a grounded duplex convenience outlet rated for 20 Amp 120 volts.

Provide a circuit schedule rack on the panel.

Provide a cue sheet clip on the panel.

Provide space for mounting cueing system head phone jacks conveniently located on panel as shown on drawings.

Provide test receptacle plate similar to the 8 position 12KW plates for testing load on individual circuit and total load on dimmer, with 2 scale loadmeter, scale selector switch and instrument circuit breaker. Meter scales to be zero to 12KW and zero to 6KW. Black and Red lines on 6KW scale at 2400 and 6000 watts respectively shall indicate maximum loading for 20 Amp and 50 Amp lighting circuits. 3 position center off spring return scale selector switch shall enable operator to select either 6 or 12 KW scale for test reading.

4. Front of House Interconnect Panel: The interconnect panel shall be of the dead front type, substantially framed and enclosed with sheet metal panels. Complete accessibility to interior components shall be provided through removable panels. Finish shall be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all connections to the panel with each terminal clearly and permanently identified by circuit or wire number. All interior wiring shall be done at factory, suitably laced and bound. It shall only be necessary for contractor to connect remote field wiring to terminal blocks provided. Rear access shall not be required for installation or maintenance. Dimensions shall not exceed those shown.

The interconnect system shall be UL listed and labeled designed to provide for:

- Dead entry interconnection of lighting
- Circuit for assignment to cross-connect panel or touring panel.
- Secondary circuit breaker protection for the lighting circuits.
- Connecting a male plug into a female receptacle without the receptacle first being de-energized.
- Disconnecting a plug from a female receptacle without the receptacle first being de-energized.
- Plugging and disconnection may be made at any time during set up, rehearsal, or production without affecting the operational status of other male plugs and female receptacles or the dimmer and non-dim circuits.

The panel modules shall contain the quantity of male plug and cord sets, female receptacles and circuit breakers, all rated at the ampacity shown on the drawings. The lighting circuit number shall be engraved on both plug sides. Lighting circuit number shall also be engraved in a lamicoid name plate attached near respective circuit breaker. Plugs and receptacles shall be two pole plus ground (3 pin) 20 or 50 Amp as indicated, Kliegl type 955G or 957G respectively. Cords shall be 36" long extra-flexible, 3 conductor heavy duty UL listed. Minimum wire gauge shall be 20 Amp #12 stranded or 50 Amp #6 stranded copper rubber covered. Cord shall be solidly anchored to plug and to panel by an offset grip-clamping device. Plugs shall be color coded black for 20 amp circuit and red for 50 amp circuit.

Each load circuit shall be protected by a single pole, fully magnetic circuit breaker. Layout and ratings of breakers shall be as shown on the drawings.

Adapter cords for connecting to touring equipment shall be provided in the quantity of 50 20-Amp and 6 50-Amp cords to be similar to above except 2 conductor, 24" long. One end of each cord to be fitted with two pole plus ground (3 pin) receptacle to mate the panel cord. Other end of each cord to be fitted with Two pole male plug Kliegl type 955 and 957.

5. Stage Manager's Portable Control Console: Stage Manager's Portable Console shall be free standing, portable, substantially framed and enclosed with sheet metal panels, housing control equipment for Stage and House Lighting circuits. Access to interior wiring and components shall be provided by hinged doors having locking latches. Equipment and device arrangement shall be as indicated. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the console with each terminal clearly and permanently identified by circuit or wire number. All wiring shall be done at factory, suitably laced, and bound.

Extra heavy duty multiple conductor copper stranded flexible cables shall be factory furnished and wired for connecting console to building receptacles. Cables shall be ten feet long fitted with multiple pin male plugs and basket weave strain relief grips each end.

Provide heavy duty hard rubber casters, swivel type with locking brake to permit ease of movement.

a. Control console shall perform the following functions:

- 1) Individual switching of selected non-dim circuits.
- 2) Group switching and/or dimming control of any group of dimming and non-dim circuits.
- 3) Visual monitoring of production activities (monitoring system is future).
- 4) Audio monitoring of production activities and paging.

b. Equipment and arrangement shall include the following:

- 1) Lock and Key Switches shall be provided to allow energization and de-energization of the dimming system. A pilot light shall be provided

- to indicate "on" position of switch. 5
- 2) Console Work Light: Provide console and instrument light for the console, so designed to illuminate the surface of the console evenly while at the same time confining the illumination to the operating sections of the console. Provide separate dimming control over intensity of console and instrument light with separate fuse protection. 7
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 - 3) Convenience Outlet: A 20 Ampere 120 volt duplex convenience outlet shall be provided. 14
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 - 4) Overload Protection: Overload and short circuit protection required shall be grouped and labeled for convenient access by the operator. Use indicating fuse holders. 17
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 - 5) Cue Sheet Holder: Provide one cue sheet holder. 21
 - 6) House Lighting Controls: Provide controls for house lighting as follows: 23
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 - Main lock and key switch control and pilot light. 26
 - Panic system control and pilot light push button with raised ring. 28
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 - 3-position center return momentary contact toggle switch for motorized master control potentiometer. 31
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 - Toggle switch for black-out control. 34
 - 7) Non-dim Controls: Provide 3 3-position on-off master switches for non-dim circuit control plus master. 36
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 - 8) Backstage Lighting Control: Provide four 3-position, momentary contact, center off switches for rehearsal/worklight control. Provide pilot light with each switch to indicate relay "on". 38
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 - 9) Stage Lighting Controls: Provide controls for stage lighting as follows: 41
 - Main lock and key switch control with pilot light. 43
 - Submaster control potentiometers with integral on-off black out switch, one per scene for total of three. Potentiometers shall be identical to those in Master Lighting Control Console. 45
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 - Toggle switch for blackout control. 48
 - In-House Phone: Provide space for phone with pilot and outlet panel mounted. Phone and pilot provided by Electrical Contractor. 50
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 - Paging Microphone: Provide receptacle for paging microphone with controls panel mounted. Equipment and wiring provided by Electrical Contractor. 53
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 - Visual Monitoring: Provide space for future visual monitoring equipment, controls and wiring. Equipment and wiring, future. 57
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- Cueing System: Provide receptacle for cueing system headset. Headset provided by Electrical Contractor.

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- Cable Storage: Provide rack at sides of console to permit connecting cables to be wrapped up to clear floor.

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- Monitor Speaker: Provide panel mounted speaker and level controls. Equipment provided by Electrical Contractor.

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6. Production Control Panel: The Production Control Panel shall be free standing, floor supported, substantially framed and enclosed with sheet metal panels housing control equipment for Stage and House Lighting circuits and miscellaneous systems. Access to interior wiring and components shall be provided by hinged doors having locking latches. Equipment and device arrangement shall be as indicated. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the panel with each terminal clearly and permanently identified by circuit or wire number. All interior wiring shall be done at factory, suitably laced and bound. It shall only be necessary for contractor to connect incoming field wiring to terminals provided. All equipment and components required to be mounted in the panel shall be installed at the factory. Certain equipment specified to be furnished under other sections of these specifications shall be delivered to the factory by the Electrical Contractor upon receipt of same from the various contractors involved.

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a. Control console shall perform the following functions:

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- 1) Individual switching of selected non-dim circuits.
- 2) Group switching any group of dimming and non-dim circuits.
- 3) Visual monitoring of production activities (monitoring system is future)
- 4) Audio monitoring of production activities.
- 5) Control of miscellaneous systems.

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b. Equipment and arrangement shall include the following:

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- 1) Lock and Key Switches shall be provided to allow energization and de-energization of the dimming system. A pilot light shall be provided to indicate "on" position of switch. Switch shall provide interlocking feature to prevent all other Stage and House lighting control points (except Master Lighting Console) from functioning when Production Control Panel is activated. This applies both to House and Stage Lighting controls.
- 2) Panel Work Light: Provide work lights for the panel, so designed to illuminate the surface of the panel evenly while at the same time, confining the illumination to the operating sections of the panel. Provide separate dimming control over intensity of panel and

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instrument lights with separate fuse protection.	5
3) <u>Overload Protection</u> : Overload and short circuit protection required shall be grouped and labeled for convenient access by the operator. Use indicating fuse holders.	7 8 9
4) <u>Cue Sheet Holder</u> : Provide one cue sheet holder.	11
5) <u>House Lighting Controls</u> : Provide controls for house lighting as follows:	13 14
- Main lock and key switch control and pilot light.	16
- Panic system control and pilot light push button with raised ring.	18
- 3-position center return momentary contact toggle switch for motorized master control potentiometer.	20 21
- Toggle switch for black-out control.	23
6) <u>Non-Dim Control</u> : Provide 3 3-position on-off master switches for non-dim circuit control plus master.	25 26
7) <u>Stage Lighting Controls</u> : Provide controls for stage lighting as follows:	28 29
- Main lock and key switch control with pilot light.	31
- Submaster control potentiometers with integral on-off black-out switch, total of six. Potentiometers shall be identical to those specified for Master Lighting Control Console.	33 34 35
- Toggle switch for black-out control.	37
- 3 x 6 scene master matrix panel associated with stage managers Portable Console Controls.	39 40
- Matrix shall be identical to that specified for Master Lighting Control Console except for quantity of positions.	42 43
- 6 x 66 group master control matrix panel associated with Production Control Panel controls. Matrix shall be identical to that specified for Master Lighting Control Console except for quantity of positions.	45 46 47 48
8) <u>Orchestra Pit Lighting</u> : Provide intensity control and associated three-way switch for orchestra pit receptacles.	50 51
9) <u>Clock</u> : Provide clock, Edwards 2411-44-6" or Simplex equal flush panel mounted.	53 54
10) <u>In-House Phone</u> : Provide space for phone with pilot, buzzer, buzzer silence switch and outlet panel mounted. Phone, pilot and buzzer	56 57

- provided by Electrical Contractor.
- 11) Cueing System: Provide receptacle for cueing system headset. Headset provided by Electrical Contractor. Power supply for cueing system to be mounted in this panel by Electrical Contractor.
- 12) Public Telephone: Provide space for phone with outlet panel mounted.
- 13) Backstage Lighting Control: Provide four 3-position, momentary contact, center-off switches for rehearsal/worklight control. Provide pilot light with each switch to indicate relay "on". Also provide three SPST switches and two 3-way switches each with a pilot light.
- 14) Stage Managers Console Receptacles: Provide receptacles to mate plugs of stage manager portable control console.
- 15) Miscellaneous Items: Controls for the following systems shall be included in the panel:
- Orchestra pit forestage lift control (cord connected portable control station).
 - Adjustable acoustical element control.
 - TV monitor (future)
 - Audio System gain controls.
- 16) Monitor Speaker: Provide panel-mounted speaker and level controls. Equipment provided by Electrical Contractor.
7. Usher's Lighting Control Station: The usher's Lighting Control Station shall be flush mounted housing House and miscellaneous lighting control devices. Access to interior wiring and components shall be provided by hinged doors, having locking latches. Equipment and device arrangement shall be as indicated. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the station, with each terminal clearly and permanently identified by circuit or wire number. All interior wiring shall be done at factory, suitably laced and bound. It shall only be necessary for contractor to connect incoming field wiring to terminals provided. All equipment and components required to be mounted in the panel, shall be installed at the factory.

a. Equipment and arrangement shall include the following:

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- 1) House Lighting Controls: Provide controls for house lighting as follows:

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- Main lock and key switch control and pilot light to indicate control power is available to control house lights.

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- 3-position center return momentary contact toggle switch for motorized master control potentiometer.

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- 2) Momentary Contact Switches for the Control of:

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- Promenade Ceiling Lights

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- Lobby Ceiling Lights

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- Emergency Egress Lighting

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- 3) Remote Dimmer and on-off Controls for:

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- Lobby Chandelier

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- Sky Lights

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- 4) Momentary contact switches shall be as specified in Section 16E, Low Voltage Control.

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- 5) Remote dimmer controls to be as indicated.

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8. Projection Booth - House Lighting Control Station:

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Station shall be as indicated providing control of House Lighting circuits.

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- Main lock and key switch for control power. When this station has control it shall not be possible for control to be taken away by any other House Lighting Control Station except for Master Lighting Console.

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- Pilot light shall indicate control power is available to control House Lights

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- 3-position center return momentary contact toggle switch for motorized master control potentiometer.

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9. Miscellaneous Lighting Equipment shall be as indicated. Material not definitely specified shall be of the quality regularly used by the manufacturer in the product he sells on the commercial market for similar application.

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B. Activities Building Equipment:

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1 Dimmer Package for General Lighting: Dimmer Packages for control of general area lighting circuits shall be as indicated. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Packages shall be complete with enclosures, dimmers, circuit breakers and control features necessary for operation.

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2 Meeting Room Master Lighting Control Station: The meeting room master lighting control station shall be flush mounted housing Meeting Room lighting controls. Access to controls shall be via hinged door having locking latch. Access to interior wiring shall be via hinged panel. Equipment and device arrangement shall be as indicated. Dimensions shall not exceed those shown. Finish to be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the station with each terminal clearly and permanently identified. All interior wiring shall be done at factory, suitably laced and bound. It shall only be necessary for contractor to connect incoming field wiring to terminal provided. All equipment and components required to be mounted in the panel shall be installed at the factory.

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a. Equipment and arrangement shall include the following:

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1) Light intensity control switches for operation of packaged dimmer systems, Kliegl type KLP - 2219 as indicated.

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2) Three-way switches as hereinbefore specified.

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3) Momentary contact switches, low voltage, as hereinbefore specified.

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4) Control diagram for retractable spots.

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5) Mode Selector Switches for dimmer intensity controls as indicated.

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C. Exhibit Hall Equipment:

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1 Dimmer Package for General Lighting: Dimmer Packages for control of general area lighting circuits shall be as indicated. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Packages shall be complete with enclosures, dimmers, circuit breakers and control features necessary for operation.

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2 Platform Dimmer Bank PD:

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a General: The dimmer banks shall be designed to operate at 120/208 Volt three phase four wire 60 Hz.

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Bank shall be wall mounted, dead front, substantially framed and enclosed with sheet metal panels. Each section shall be provided with full size hinged door having cabinet locking handle. Equipment and device arrangement shall be as shown on the drawings. Dimensions shall not exceed those shown. Finish shall be baked enamel, color as selected. Terminal strips

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of adequate rating shall be provided for all wiring connections to the
banks with each terminal clearly and permanently identified by circuit
or wire number. All interior wiring shall be done at factory, suitably
laced and bound. It shall only be necessary for Contractor to connect
incoming field wiring to terminals provided.

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All equipment necessary for the operation of the banks under the intent
of these specifications shall be provided with overload and short circuit
protection. Electrical system serving dimmer banks will limit available
short circuit current to maximum of 5000 Amps Symmetrical RMS. All
circuit breakers shall be fully magnetic. Entire dimmer bank shall bear
UL label.

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b. Main section of dimmer bank shall contain

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receptable first being de-energized.

- Disconnecting a plug from a female receptacle without the receptacle first being de-energized.

- Plugging and disconnection may be made at any time during set up, rehearsal, or production without affecting the operational status of other male plugs and female receptacles or the dimmer and non-

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g. Provide a grounded duplex convenience outlet rated for 20 ampere 120 volts.	5 6
h. Provide a circuit schedule rack on the panel.	8
i. Provide a cue sheet clip on the panel.	10
j. Provide test receptacle plate similar to the 4 position 3KW plate for testing load on individual circuit and total load on dimmer, with loadmeter and instrument circuit breaker. Meter scale to be zero to 3KW. Black line at 2400 watts shall indicate maximum loading for 20 Amp lighting circuits.	12 13 14 15 16
k. Platform Lighting Control Panel built into patch panel shall perform the following functions:	18 19
- Individual switching and/or dimming control of dimming and non-dim circuits.	21 22
- Group switching and/or dimming control of any group of dimming and non-dim circuits.	24 25
- Pre-setting of any or all dimming circuits in advance without changing or affecting the setting or intensity of any circuits in operation.	27 28 29
- Switch operation or cross fade from one group of pre-set intensities to another.	31 32
- Pile on one group of pre-set intensities to another group of pre-set intensities.	34 35
- Simultaneous brightening or dimming of groups of circuits while maintaining their relative pre-set intensities (proportional dimming).	37 38 39
l. Lighting Control Panel equipment and arrangement shall include:	41
- Hinged anodized aluminum mounting plate.	43
- Lock and Key switch for energizing the dimmer control system, with pilot light to indicate "on" position.	45 46
- Panic System control pushbutton rear lighted with raised ring for House Lighting.	48 49
- Toggle switches for control of non-dim circuits.	51
- Independent Master potentiometer with integral on-off black out switch similar to that specified under Stage Lighting Equipment.	53 54
- Split fader mechanism with black-out switches and pilots similar to that specified under Stage Lighting Equipment.	56 57

- Dimmer controller potentiometers 12 per each of two preset scenes for total of 24. 12 shall have integral "on-off" switch and 12 shall have integral 3-position "Fader-off-Independent" switch similar to those specified under Stage Lighting Equipment.

m. Exhibit space Lighting Control Panel #1 built into patch panel shall include:

- Lock and Key switch for energizing Exhibit Area Lighting controls and assigning same to master or local operation. Master position permits this control panel to control designated Lights in Areas 1, 2, and 3. Local position permits this control panel to control Lights in Area 3 only and permits Exhibit Space Lighting Control Panels 2 and 3 to control lights in Areas 2 and 3 respectively.
- Control pilot lights.
- Toggle switches for Emergency Lighting.
- Hinged anodized aluminum mounting plate.
- Momentary contact low voltage lighting switches as specified in Section 16E.
- Dimmer controller and master controller potentiometer with built-in independent-master switch or on-off switch as indicated for control of packed dimmer systems, similar to those specified under Stage Lighting Equipment.

4. Exhibit Hall Lighting Control Stations #2 and #3: Control stations shall be flush mounted housing Exhibit Hall lighting controls. Access to controls shall be via hinged door having locking latch. Access to interior wiring shall be via hinged panel. Equipment and device arrangement shall be as indicated. Dimensions shall not exceed those shown. Finish to be baked enamel, color as selected. Terminal strips of adequate rating shall be provided for all wiring connections to the station with each terminal clearly and permanently identified. All interior wiring shall be done at factory, suitable laced and bound. It shall only be necessary for contractor to connect incoming field wiring to terminals provided. All equipment and components required to be mounted in the panel shall be installed at the factory.

a. Equipment and arrangement shall include the following:

- Lock and Key switch for energizing respective exhibit area lighting controls.
- Control pilot lights.
- Toggle switch for emergency lighting.
- Momentary contact low voltage lighting switches as specified in

Section 16E.

- Dimmer controller and master controller potentiometers with built-in independent master switch or on-off switch as indicated for control of packed dimmer systems, similar to those specified under stage lighting equipment.

INSTALLATION

Install all items in conformity with standard theatrical trade practices, manufacturer's recommendations and Architect's direction.

Consult and coordinate work with trades doing adjoining work.

Verify all site conditions before installation and, insofar as possible, before fabrication commences.

Position all items accurately as indicated on drawings or directed by Architect and true to plumb, line and level.

Install all equipment except portable equipment firmly in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. All switches, connectors, jacks, receptacles, outlets, conductors and conductor terminations shall be clearly, logically and permanently marked during installation.

All cord connected equipment shall be subject to the requirements of Chief Electrical Inspector of City of Sacramento.

SUBMITTALS

- A. Submittals, Substitutions, etc.: Drawings for approval prior to fabrication:

Complete, fully dimensioned shop drawings of all major components.

Schematics showing the complete wiring of all lighting control equipment and systems to be furnished with all components identified and all conductors labeled. Distinction shall be clearly made as to factory wiring and required field wiring.

Catalog or standard data sheets for proprietary items.

Power requirements and connection points for all required field raceway and wiring connections.

- B. Samples: The Contractor shall provide working samples of certain proposed substitute equipment to be delivered to premises designated for examination. Handling, shipping and delivery to, and removal from the premises, of any sample required shall be at the expense of the Contractor. The Contractor shall be responsible for the arrangement of and cost of electrical supply required to properly test any lighting instrument or item of equipment.

Samples of proposed substitute equipment will be compared to samples of specified equipment. Samples of specified equipment for comparison will be supplied at no cost to the Contractor.

Samples for comparison shall include:

Each lighting fixture type including lamping.
 Plugging boxes and strips.
 Stage cable junction box.
 Cable suspension kit
 Patch panel cords, receptacles and plugs
 Rondels
 Filters
 SCR dimmer unit
 Terminal blocks
 Dimmer potentiometer
 Typical enclosure construction
 Enclosure finishes
 Floor boxes, pockets
 Receptacles

All drawings, submittals and proposals must be approved by the Architect before the Contractor or manufacturer commences fabrication or installation.

- C. Record Drawings, Maintenance Data: Prior to performance of system demonstration, submit to the Architect three complete sets of "as-built and approved" drawings showing all systems and elements as installed.

At the same time, submit three sets of maintenance data and parts lists. Maintenance information shall be provided on all major units and principal components of the system.

- D. Lighting Fixtures: Contractor submitting other than specified fixtures shall include performance data taken and reported in compliance with the "Recommended Practice for Reporting Photometric Performance of Incandescent Filament Lighting Units used in Theatre and Television Productions." For purposes of establishing the validity of such submission, the manufacturer shall, when required by the Architect, supply this data from an independent testing laboratory.

- E. Dimming System: Contractor submitting other than the specified equipment shall include pertinent data, charts and drawings showing in what respect the system will function in accordance with the specifications, and in what way it will deviate from the specifications. In the case of the control system the Contractor shall submit the name of the manufacturer, and a list of ten or more operating systems of the type specified which meet the performance and control functions designated.

SECTION 16I - CUEING SYSTEMRELATED DOCUMENTS

The requirements of Division 1 apply to the work specified in this section.

DESCRIPTION OF WORK

This section includes the furnishing and installation of a complete cueing system as described herein and shown on the drawings.

GENERAL

See Section 16A for Electrical General Requirements. See also Sections 16 B and 16C.

SYSTEM COMPONENTS

Cueing Headsets shall be Western Electric Co., #52-SW, Cable Electronics Co., #P/N1400PL or equal with adjustable headband, boom, mike housing and vinyl cordset terminated in a 3-conductor $\frac{1}{4}$ " dia. phone plug with built-in cable clamp. Phone plug shall be constructed of brass, silver plated. Cord lengths shall be five, ten, or fifteen feet long as indicated.

Cueing Headset receptacles shall be provided on 1-gang stainless steel plates suitably engraved. The construction of each receptacle shall include an antisidetone electronic network to ensure maximum voice quality.

Cueing System Power Supply shall have an output of 12 volts, filtered DC, at one ampere. The rectifier shall maintain a constant voltage under load. Filtering shall hold AC hum to less than 1% measured against a 1,000 Hz, 10db test signal. Power supply choke coil shall have a maximum 1 ohm DC resistance and a minimum 100 ohm AC resistance measured with a 1,000 Hz test signal. Mount power supply inside stage right production control panel. Power supply shall be Executone PS15 or approved equal.

SYSTEM OPERATION

The system shall provide a common intercommunication channel between all headset stations connected into the system.

INSTALLATION

Electrical Contractor shall retain the services of the duly appointed representative of a nationally known concern engaged in the manufacture or distribution of equipment as specified above, who shall furnish all equipment, supervise all connections to same and place the system in operation.

The technician and workmen employed shall be particularly skilled in this type of work.

All cables entering a terminal cabinet shall be identified with Brady or E-Z Code wire markers.

Each cable run on the wiring diagram shall be identified with the exact wire marker code (numerical or alphabetical) as appears in the terminal cabinets.

All system wiring shall be as indicated on plan. Wire shall be run in conduit, and as required by the manufacturer. The system shall test free from grounds, opens and short circuits.

Station Locations shall be identified by final room designations and in all ways the one-line wiring diagram shall relate as closely as possible to the architectural blueprints.

SUBMITTALS

One line diagram of complete system showing all outlets, cabinets, etc., and associated wiring. Provide 6 copies.

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SECTION 16J - IN-HOUSE COMMUNICATION SYSTEM

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RELATED DOCUMENTS

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The requirements of Division 1 apply to the work specified in this section.

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DESCRIPTION OF WORK

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This section includes the furnishing and installation of a complete In-House Communication system as described herein and shown on the drawings.

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GENERAL

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See Section 16A for Electrical General Requirements. See also Sections 16B and 16C.

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SYSTEM OPERATION

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System shall consist of multi-channel, multi-station, automatic selection intercommunication equipment consisting of Control Stations, Central Exchange equipment cabinets containing all necessary relays, selection circuitry, tone signal generators, audio amplifiers, power supplies, interwiring, Main Junction Box and all other required accessories, to provide performance as herein specified.

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The system shall be an electronically switched speaker-microphone type intercommunication system with central control equipment and solid state amplification. It shall be designed for operation by both parties in a conversation on a "Hands-Free" basis without operation of controls by either party.

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In addition to "Hands-Free" operation, optionally used manual speech switching and non-loudspeaking-telephone handset operation shall also be simultaneously available for possible use within the system. Selection and connection of one station to another shall be established through depression of the digit button combination for the called station.

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It shall also be possible to establish a preselected number of connections by depression of only one digit button. This facility shall be an optional addition to the normal selection method involving two or three digits.

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Rotary dial telephone operation shall not be acceptable under these specifications.

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Central Exchanges shall be completely modular - plug in design and shall be built up with telephone type relays, cross-bar switches and similar circuitry.

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Control Stations shall be able to originate calls to, and receive calls from, any other Control Station in the system (including those that may be added to future expansion).

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All calls from Control Stations to other Control Stations shall be handled through a central switching and amplification exchange. Amplification shall be accomplished via solid state, plug in type duplex amplifiers in each conversation link. Duplex amplifiers shall provide electronic switching of speech directions for "Hands-Free" operation. Design of electronic amplification and switching shall insure natural two-way conversation without clipping of syllables. Efficient operation of the system shall be possible with stations located over distances up to 1½ miles (400 ohm loop resistance).

Optionally used manual switching of speech direction shall be provided to give the transmitting channel priority. This facility shall be usable for operation of high level paging system with optional "Hands-Free" reply as well as to provide performance under adverse ambient conditions.

During any single conversation, either party shall have complete freedom to change to or from manual or "Hands-Free" operation without interruption of conversation.

The Central Exchange shall be so designed that at time of installation, or at any time, thereafter, minor jumper arrangements can be made to give calling party automatic manual control of conversation switching, should the calling party optionally choose to use this mode of operation.

It shall be possible for calls to be terminated by either calling or called party through depression of Release Button. Calls may also be terminated by returning the handset to its cradle when handset is used at a station so equipped.

System shall include the following features as detailed further on in this specification:

Digital - "Touch-Button" - call selection of any station.

"Hands-Free" - conversation without operation of controls for both called and calling parties.

Direct Selection - of preselected groups of stations via single digit button using the standard digit selection keyboard of any Control Station.

Camp-On - of calling party when selecting a busy station - with alert tone and automatic connection.

Executive Priority - breakthrough for selected Control Stations when calling a busy line.

Expandable Central Exchanges shall be delivered, wired and installed with complete wiring, receptacles, and cabinet space to accept the following future facilities on a plug-in basis with all interwiring, termination, power and interconnections to be initially provided: Call Transfer, Group Call, Group Hunting, Secretary-Transfer, Staff Location-Pocket Page.

SYSTEM SIGNALING

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Push button calling codes for station numbers and activation of special features shall be transmitted via the two pair standard cable installation to the exchange. The system shall be so designed that when the first button is depressed, the calling station shall be identified at the exchange and reception of the calling code shall take place. Indication that the calling extension is identified and connected to the exchange register shall be provided by reception of a tone at the calling station which shall cease when the button is released. The remaining digits shall then be pressed in sequence.

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When a non-loudspeaking station is called, or when the called loudspeaking station is in the private mode, an interrupted ringing tone shall be heard at both calling and called stations. If call is not answered, the interrupted tone shall time out in approximately 10 seconds.

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When the called station is in non-private (remote reply) mode, a single call tone shall be heard before the connection is established.

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When the extension called is busy, an interrupted busy tone shall be heard at the calling station. The busy tone shall time out in approximately 15 seconds.

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The volume of tone signals shall be adjustable on the tone generator located in the Central Exchange.

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30SYSTEM COMPONENTS Executone Inc., ITT Co. or equal. Numbers given are Executone.32
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Desk type Control Stations shall be provided with call origination facilities to an unlimited number of locations via digital "Touch-Button" selection. Each Control Station shall be provided with a 6 foot connecting cord with a six prong plug. Numbers and symbols shall be moulded into buttons in contrasting color. Control Stations shall be Executone Model 411HD or approved equal.

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Wall mounted Control Stations shall be provided with call origination facilities to an unlimited number of locations via digital "Touch-Button" selection. The numbers and symbols on the selector buttons shall be, moulded into the buttons in contrasting color. Each Control Station shall be provided with a 4 foot connecting cord with a six prong plug. Control Stations shall be Executone Model 400HDS or approved equal.

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Central Exchange cabinet mounted with automatic crossbar switching and shall consist basically of two cabinets, an interconnecting cabinet cable, plug-in relay frames with heavy-duty telephone type relays, crossbar switches, and a separate power supply. The exchange shall handle the switching for digital "Touch-Button" selection of up to 100 lines (control, staff or special area stations). The exchange shall be provided with three conversation links for simultaneous conversations with facility to add three future links.

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The Basic Exchange shall include:

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Camp-On - Facilities shall be provided to enable caller to Camp-On to busy extension. Call will connect automatically, when conversation is terminated.

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Priority - Facilities shall be provided to enable any one of a number of optionally selected stations to break into a call in-progress, if caller receives a busy signal.

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Direct Selection - Facilities shall be provided for connection of up to four groups of ten extensions per group. Any station may have access to one of these groups. A station within the selected group may be called by merely depressing a single digit button.

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The maximum loop resistance (resistance between Exchange and Station) shall be up to 400 ohms per loop without detriment to speech quality.

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For ease of installation, maintenance and expansion, all modules shall be plug and jack connected. Modular construction shall facilitate easy removal and replacement of all modules. The cable from the Main Junction Boxes shall be plug and jack connected to the exchange. The exchange shall contain all electronic circuitry necessary to provide lamp and tone signals to all stations. The exchange shall be easily expanded without sacrificing existing equipment.

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The Basic Central Exchange shall be housed in two self-supporting, gray steel cabinets. The maximum dimensions of each cabinet shall be 37" wide x 84" high x 18-3/4" deep (including feet). Connecting cables to the main junction box shall be provided as a part of the Central Exchange.

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JUNCTION BOX

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Main Junction Box shall consist of five terminal blocks. The terminal blocks shall be mounted on a metal base. A maximum of 20 Stations shall be connected to each terminal block. Each terminal block shall contain 100 3-prong tin plated phosphor bronze clip type terminals arranged in two columns of 50 each. A total of 1500 hookup terminals shall be provided to accommodate 100 extensions. For ease of installation and maintenance, fanning strips shall be provided. A removable protective metal cover shall be provided. The maximum dimensions shall be 31" wide x 20" high x 3" deep.

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Secondary junction boxes shall be identical to main junction box except for quantity of terminal blocks. Terminal block quantity shall be as required for quantity of stations shown plus 50% spare.

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AUXILLIARY SIGNALING DEVICES

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Auxilliary signal lamps where indicated on the plans shall consist of a moulded white Plexiglas translucent triangular shaped dome with one green indicator lamp. The lamp shall operate on 24 volts at 170 ma. The dome shall be secured to a stainless steel hinged cover for mounting on a square outlet box. A special snap-type lock shall be provided to permit

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instant lamp replacement. The auxilliary signal lamp shall flash repeatedly whenever its associated control station is called by another control station.

Auxilliary signal buzzers where indicated on the plans shall consist of a compact flush-mounted buzzer which can be installed in a two-gang outlet box. The buzzer shall operate on 24 volts at 125 ma. and be rated at 75 db at a distance of 10 ft. The auxilliary signal buzzer shall sound whenever its associated control station is called by another control station. The buzzer faceplate shall contain a screw-driver adjustment to adjust the signal duration from one-half second to five seconds.

Wall Receptacles shall be 6 pin with stainless steel faceplate, Executone Model J4105W41 or approved equal.

INSTALLATION

Wiring throughout the entire system shall be installed in conformance with standard telephone company practice.

Final connections and termination shall be performed by factory trained technicians employed by an authorized distributor of the specified equipment manufacturer.

Equipment Cabinets shall be provided with Siemons, Buchanan or equal terminal blocks (GB-31D) with attached Western Electric Company fanning strips.

Trunk Cables shall be connected to the solder lugs of the terminal blocks.

All station cables shall be run through the fanning strips to the screw terminals of the terminal blocks.

Audio Cables within the terminal cabinets shall be bound with lacing cord so that the cables are in tight contact for their entire length.

Audio Circuit Wiring external to the equipment cabinets shall be of the type of cable that will allow the shields to be insulated from ground and the audio circuits.

The shields shall be grounded at the point of lowest audio level only and shall be free of any other ground for their entire length.

Where two cables join or connect together on a terminal strip, the shields shall be insulated from all other conductors and connected together in a manner similar to the cable conductors.

Cables entering a terminal cabinet shall be identified with Brady or E-Z Code wire markers.

Upon completion of installation six (6) copies of a one-line "as-built" wiring diagram shall be furnished to the Owners.

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Each cable run on the wiring diagram shall be identified with the exact wire marker code (numerical or alphabetical) as appears in the terminal cabinets.

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Station Locations shall be identified by architectural room numbers and in all ways the one-line wiring diagram shall relate as closely as possible to the architectural blueprints.

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SUBMITTALS

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Submit 6 copies of one line diagram complete system showing all stations, cabinets, etc. and associated wiring.

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Submit 6 copies of all product information showing equipment and materials used in the system.

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SECTION 16K - STANDBY ELECTRICAL SYSTEMRELATED DOCUMENTS

The requirements of Division 1 apply to the work specified in this section.

DESCRIPTION OF WORK

This section includes the furnishing and installation of a complete stand-by electrical system as described herein and shown on the drawings.

GENERAL

See Section 16A for Electrical General Requirements. See also Sections 16B and 16C.

EQUIPMENT AND MATERIALS

Engine-Generator set shall be Onan Model 170WB-4XR8, KOHLER 170R71 or approved equal arranged for natural gas operation, 170KW 265/460 volt 3 phase 4 wire grounded wye at 0.8 power factor lagging.

Generator set shall provide standby electrical power in the event of failure of commercial service, in which cast engine shall start automatically and loads shall transfer to generator. Load transfer shall occur within 30 seconds. Set may be controlled by either transfer switch.

Return of commercial service shall cause automatic retransfer of loads back to commercial service and shut down the generator.

Engine-generator set shall be equipped with the following features and accessories:

Lubrication - a gear-type lubricating oil pump will supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings, and valve rocker mechanism. Provide replaceable filter.

Air cleaners - One or more engine-mounted dry type air cleaners of sufficient capacity to protect working parts of the engine from dust and grit shall be provided.

Cooling - A radiator and fan of a type and capacity recommended by the engine manufacturer. Include anti-freeze protection. Provide suitable circulating pump.

Safety Controls - The engine shall be equipped with automatic safety controls which shut down the engine in the event of low lubricating oil pressure, engine overspeed and high temperature.

Mountings - The engine shall be equipped with suitable support legs or base for mounting on a concrete foundation or a suitable steel base.

Suitable rubber block or spring type vibration isolators shall be provided between the engine and its concrete foundation.

Control Panel - Control panel shall be generator mounted. Control panel shall include but not be limited to:

Water temperature gauge
AC voltmeter
Frequency meter
AC ammeter
Switch, ammeter phase selector
Circuit breaker
Oil pressure gauge
Running time meter
Local operation selector switch
Radio suppression

Exhaust System - A suitable silencer to provide residential silencing shall be furnished with the engine.

Weatherproof Housing - A suitable housing shall be provided for outdoor installation of set.

Starting - The engine shall be equipped with an electric starting system of sufficient capacity to crank at a speed which will start the engine under full range of ambient conditions of locale.

Nicad batteries with sufficient capacity to crank the engine for at least 30 seconds at firing speed in the ambient temperatures and with capacity for starting the engine a minimum of three times using appropriate starting aids. Batteries to be engine mounted.

Automatic Starting Controls - Automatic controls shall be furnished to provide automatic cranking of the engine when normal power fails. Equipment shall prevent excessive cranking which could damage cranking motor. (Automatic or manual stop shall be provided.)

A test switch to permit manual operation of start-stop system will be included.

Fuel System - Engine shall operate on natural gas available at 1100 BTU and 5 PSI. Provide fuel lines and fittings including electric solenoid shut off valve, dry fuel filter, electric fuel solenoid and primary and secondary pressure regulators. Fuel line connections shall be flexible.

Battery Charger - Provide automatic battery charger LaMarche Model A5, Exide or approved equal suitable for engine batteries provided. Unit to operate on 120 volt input. Mount in raintight enclosure suitably ventilated.

Automatic Transfer Switch - Automatic transfer switches 265/460 volt 3 phase 4 wire shall automatically start the generator and

and transfer load in event of commercial voltage falling to 70 percent of nominal. Switch located at theatre to be 100 Amp. Switch at Activities Building to be 200 Amp.

Switches shall automatically restore load to commercial source when a minimum of 90 percent normal voltage is available.

Following auxiliary features shall be provided:

2-30 minute adjustable delay on restoration to normal power.

2-30 minute adjustable delay on stopping engine after normal power has been restored.

1-3 second time delay to ignore momentary outages of less than 3 second duration, non-adjustable.

Line ammeter and voltmeter, all phases, 3 phase, 4 wire.

Four position control switch for Stop-Hand Crank-Test-Automatic.

Indicating lights showing which service, normal or emergency, is serving load.

Switches shall be Zenith Series 62T, ASCO or approved equal mounted in NEMA I enclosures as shown on drawings.

Four auxiliary contacts, field convertible for miscellaneous interlocking.

Material not definitely specified shall be of the quality regularly used by the manufacturer in the product he sells on the commercial market.

Material shall be new and free from all defects or imperfections that might affect the serviceability and appearance of the finished product. Gaskets and seals shall be resistant to the fluids which they are designed to retain or to exposure to dry atmosphere.

INSTALLATION

Equipment shall be installed in accordance with manufacturer's instructions. It shall be inspected also by a representative from the manufacturer. Equipment shall be given tests as required to produce a satisfactory result, in the opinion of the Architect.

SUBMITTALS

Submit complete drawings, cuts, diagrams, etc., in 6 copies to show operation, installation and equipment used.

SECTION 16L - PRODUCTION MONITORING SYSTEMRELATED DOCUMENTS

The requirements of Division 1 apply to the work specified in this section.

DESCRIPTION OF WORK

This section includes the furnishing and installation of a complete Production Monitoring system as described herein and shown on the drawings.

GENERAL

See Section 16A for Electrical General Requirements. See also Sections 16B and 16C.

SYSTEM OPERATION:

System shall consist of multi-station reception, amplification and distribution equipment providing production monitoring and paging facilities as herein specified and shown on drawings.

Speakers at designated locations shall, by preselected control, receive either main house system program or independent system signals from production monitor microphone at catwalk. It shall be possible to override both House and Independent signals for purpose of paging from stage Manager's Console.

EQUIPMENT

Monitor microphone located at catwalk shall be unidirectional dynamic with a cardioid directional characteristic, Shure 500 Electrovoice or approved equal for bracket mounting with five feet of flexible microphone cable.

Monitor loudspeakers shall be eight inch flush ceiling mounted with backbox and grille, Jensen K-950 with matching transformer, Jensen 70CV4. Executone or approved equal may be used.

Paging microphone located at stage managers console shall be ceramic close-talking type with built-in DPDT switch to override program. Electro-voice 717 or approved equal with mounting bracket and 5 foot coiled microphone cable with Cannon XLR-3-126 connector.

Microphone receptacles shall be capable of receiving the Cannon XLR-3-126 connectors.

Combination amplifier, mixer, power supply and control equipment shall be located at Production Control Panel. Amplifier shall be 200 watt solid state similar to that specified under Sound Amplification Systems Section of these specifications.

Panel Mounted Monitor Speaker shall be eight inch flush panel mounting with backbox and protective grille and screen, Jensen K-950 with 70CV4 transformer. Executone or approved equal.

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Panel Mounted Level Control for panel monitor speaker shall be Jensen type LVP. Executone or approved equal may be used.

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INSTALLATION

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Wiring throughout the entire system shall be installed in conformance with standard telephone company practice.

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Final connections and termination shall be performed by factory trained technicians employed by an authorized distributor of the specified equipment manufacturer.

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Equipment Cabinets shall be provided with Siemons terminal blocks (GB-31D) with attached Western Electric Company fanning strips (#102D)

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Trunk Cables shall be connected to the solder lugs of the terminal blocks.

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All station cables shall be run through the fanning strips to the screw terminals of the terminal blocks.

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Audio Cables within the terminal cabinets shall be bound with lacing cord so that the cables are in tight contact for their entire length.

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Audio Circuit Wiring external to the equipment cabinets shall be of the type of cable that will allow the shields to be insulated from ground and the audio circuits.

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The shields shall be grounded at the point of lowest audio level only and shall be free of any other ground for their entire length.

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Where two cables join or connect together on a terminal strip, the shields shall be insulated from all other conductors and connected together in a manner similar to the cable conductors.

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Cables entering a terminal cabinet shall be identified with Brady or E-Z Code wire markers.

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Upon completion of installation six (6) copies of a one-line "as-built" wiring diagram shall be furnished to the Owners.

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Each cable run on the wiring diagram shall be identified with the exact wire marker code (numerical or alphabetical) as appears in the terminal cabinets.

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Station Locations shall be identified by architectural room numbers and in all ways the one-line wiring diagram shall relate as closely as possible to the architectural blueprints.

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SUBMITTALS

One line daigram of complete system showing all stations, cabinets, etc. and associated wiring.

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SECTION 16M - SOUND AMPLIFICATION SYSTEMSRELATED DOCUMENTS

The requirements of Division 1 apply to all work specified in this section.

DESCRIPTION OF WORK

The contractor shall furnish and install complete sound systems with all necessary apparatus and equipment, wiring, etc., required to insure on completion systems of broadcast quality in excellent working order as specified herein and on the specification drawings.

Supervise the installation of all sound system conduit and boxes in accordance with electrical plans and specifications and provide shop drawings to the electrical contractor indicating required outlet box, speaker outlet, etc., locations.

The sound amplification systems shall include but are not limited to the following:

- Microphones and accessories
- Control equipment
- Power amplifiers
- Rock-mounted equipment
- Loudspeakers and associated equipment
- Miscellaneous equipment

GENERALInitial Tests and Adjustments:

Furnish all equipment necessary to perform tests and work required to modify the performance of the systems so as to be in accordance with Electronic Industries Association Standards RS 219 and RS 160.

Loudspeaker Line Impedance: The contractor shall measure the impedance of each loudspeaker line entering the equipment rack, without amplifier connected, but with all loudspeakers connected. The absolute value shall be measured at 200, 500, and 2000 Hz. Loudspeaker level control shall set to zero attenuation.

Hum and Noise Level: The hum and noise level of the overall system shall be measured for each microphone input channel and line-level input channel. Gain controls shall be adjusted for optimum signal-to-noise ratio and such that full amplifier output would be achieved with -55 dBm input level at a microphone input and 0 dBm at a line-level input. Microphone and line-level inputs shall be terminated with shielded resistors of 150 and 600 ohms, respectively.

Power Output and Signal Level Adjustment Within Spaces: The electrical distortion of the overall system shall be measured for each microphone input channel and line-level input channel. Gain controls shall be

adjusted to conform with tests specified in initial test and adjustments. 5
A 1000 Hz sine-wave signal from an oscillator having less than 0.5% total 6
harmonic distortion shall be applied at the input tested, at a level 7
required to produce full amplifier output. (Note, that a 40 dB or 50 dB pad 8
with 150-ohm output impedance is required for driving a microphone-level 9
input with most available oscillators.) A distortion analyzer shall be 10
used to measure the output level and total harmonic distortion of the 11
amplification and control equipment. In the absence of a distortion 12
analyzer, a VTVM may be used to measure the output level, and lack of 13
clipping or apparent deformation of a sine-wave input signal at the 14
power amplifier output (as seen on an oscilloscope having a 5 MHz 15
minimum bandwidth) conformance to acceptable limits will be subject to 16
review by the acoustical consultant. All measurements shall be made with 17
loads actually incurred in system operation. Power amplifier loads shall 18
be actually incurred in system operation. Power amplifier loads shall 19
be resistors equal to the nominal impedance of the output terminals used 20
in the system. 21

Freedom from Parasitic Oscillation & Radio-Frequency Pickup: Set up 23
systems for each mode of operation specified in the functional require- 24
ments and check to insure that all systems are free from spurious 25
oscillation and radio-frequency pickup, both in the absence of any audio 26
input signal and also when the system is driven to full output at 100 Hz. 27
Employ an oscilloscope having a 5 MHz bandwidth and loudspeaker monitor- 28
ing for these checks. 29

Loudspeaker Phasing: Checks of loudspeaker phasing for distributed 31
loudspeakers in the same room and for the effects system shall be 32
performed by listening tests using speech or music program material. 33

A listener (as determined by Architect and Acoustical Consultant) moving 35
slowly from beneath one loudspeaker to the next should sense a single 36
apparent sound source which is at first located at the first loud- 37
speaker, but which begins to shift smoothly and continuously toward the 38
second loudspeaker as he nears the halfway point. At the latter point, 39
the sound should appear to come from a point on the ceiling midway 40
between the loudspeakers. Any deviation from such observation indicates 41
either incorrect phasing of one loudspeaker with respect to the other, 42
or faulty operation of one or both loudspeakers. Phasing checks shall 43
also be performed between systems in rooms that can be combined. 44

For the central loudspeaker cluster, phasing of high-frequency horn 46
loudspeakers with respect to one another shall be performed by listening 47
tests using speech or music program material. A listener shall move 48
slowly from the coverage of one high-frequency horn to the next with the 49
loudspeakers connected nominally in-phase and out-of-phase. With the 50
loudspeakers properly in phase, the listener should not notice any 51
degradation of program material in the overlap zone; instead coverage 52
should sound uniformly high in quality throughout the area covered. 53
Phasing of the low-frequency loudspeakers with respect to the high 54
frequency horns shall be accomplished by listening tests using speech 55
or music program material and a sine-wave test signal warbled about 500 Hz. 56

The listener shall be located on the axis of High-Frequency Horn No. 1 serving the audience area at the balcony front. The low-frequency loudspeakers shall be switched from nominally in phase to nominally out of phase with respect to the high-frequency horns. With the loudspeakers properly in phase the quality and clarity of the music or speech should be greater and the test signal should clearly come from the loudspeaker, and not jump from the loudspeaker to the surrounding space.

Freedom from Buzzes, Rattles and Objectionable Distortion:

Apply a high-quality music signal to each system, adjusting the system for frequent peaks of 95 dB sound pressure level and also apply a sine-wave sweep from 50 to 5,000 Hz at a level 6 dB below full amplifier power and listen carefully for buzzes, rattles, and objectionable distortion. Correct any causes of these defects, unless the cause is clearly outside the sound amplification system equipment and installation, in which case the cause shall be brought to the attention of the Architect and acoustical consultant.

Written Report:

Prepare a written report presenting the results of these tests, including numerical values where applicable, for review by the Architect and acoustical consultant prior to demonstration and acceptance testing.

Loudspeaker Balance and Gain Control Settings:

Balance all loudspeakers to insure maximum evenness of coverage in each system. Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum signal-to-noise ratio and signal balance and shall then be capped to prevent tampering. (Settings may require further adjustment as a result of testing by the acoustical consultant).

Balancing high-frequency and low-frequency loudspeakers of the central system shall be accomplished by the contractor using a peak-noise input, either filtered to include 1/3 octave bands at 250 and 1,000 Hz or measured with such filtering, and use of the amplifier and crossover network gain controls.

Demonstration and Acceptance Testing of Completed Installation:

When all diagrams have been supplied and have been completed, the initial tests and adjustments specified hereinbefore, he shall notify the Architect in writing that the installation fulfills this specification and is complete and ready for inspection by representatives of the Architect, building owner and acoustical consultant.

Demonstration: Demonstrate the operation of each major component and of the complete installation, using each microphone furnished, all required microphone positions, and all other input equipment.

Acceptance Tests: These acceptance tests will be performed by the acoustical consultant acting as the representative of the Owner, with the support and cooperation of the contractor and installer.

Listening Tests: These tests may include subjective tests by observers at various positions, listening under various operating conditions. Speech intelligibility surveys may be part of this testing procedure.

Equipment Tests: Tests may be performed on any item of equipment or group of items to determine whether it meets the pertinent specifications. Any measurements deemed necessary by the acoustical consultant may be made for frequency response, distortion, noise or other characteristics.

Provide an expense-free maintenance service for a period of one year after final acceptance of the installation. This service shall consist of at least six bi-monthly visits to the site for checking and adjusting of equipment.

Instruct the Owner's operating personnel in the operation, care and maintenance of the installation before the installation can be considered complete.

All service calls must be answered within twenty-four hours.

Diagrams/Drawings and Instruction Manuals: Furnish three copies each of the following items.

Simplified block diagrams of the system giving the essentials of the installation and their functional relations. One copy each of system's diagram shall be mounted behind glass at the control room.

Prepare inked drawings of the Exhibit Hall stage positions as shown on Drawings. The inked drawings shall be mounted behind glass at the control position.

Prepare a complete instruction book including all block and schematic diagram, wiring diagrams, sizes and technical descriptions of components.

FUNCTIONAL REQUIREMENTS

Theatre: The sound amplification system for the Theatre shall provide:

Reinforcement of live activities taking place on the stage with coverage for the entire audience seating area.

High-quality monophonic playback of single or dual-channel tape and disc recorded material.

High-quality monophonic reproduction of motion picture sound.

High-quality monophonic reproduction of AM-FM broadcasts.

Tape recording or feeds for broadcasting of live activities on the stage simultaneously with reinforcement.

Dubbing from disc recordings to tape.

Stereophonic playback of theatrical sound effects using portable loudspeakers which may be located on or off stage.

Connection to the Meeting Room and Exhibit Hall systems.

Exhibit Hall: The sound amplification system for the Exhibit Hall shall provide:

Reinforcement of speech originating from any of five stage locations within the Exhibit Hall to allow performers to be heard and understood clearly in either the total facility or designated subdivisions.

Playback of single-channel motion picture sound from any of five locations with coverage as in above.

High-quality monophonic playback of single or dual-channel tape and disc recordings with coverage as in above.

Monophonic recording of events originating in the total facility or in designated subdivisions.

Local control of microphone levels with a portable console.

Reproduction of signal from an AM-FM receiver.

Feed for broadcasting of live activities simultaneously with reinforcement.

Connection to Theatre and Meeting Room systems.

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Meeting Rooms: The sound amplification system for the meeting rooms shall provide:

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Reinforcement of speech activities taking place in the first and second floor Activity Building Meeting Rooms.

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Reinforcement of live activities taking place within any particular Meeting Room subdivision for listeners within that subdivision or for listeners in that and adjacent subdivisions.

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Capability for tape recording of live activities taking place within the facility simultaneously with reinforcement.

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Reproduction of pre-amplified motion picture or other recorded sound within any subdivision or combination of subdivisions using source equipment not specified in this report.

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Local volume control of all live reinforcement and facilities for local control with portable consoles.

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Connection to Exhibit Hall and Theatre systems.

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SUMMARY DESCRIPTION OF THE SYSTEMS

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Theatre: The Theatre sound amplification system employs a central cluster of theatre-type high and low-frequency horns, designed for even coverage and control of directional characteristics throughout its frequency range. The location of the loudspeaker cluster should preserve directional realism for most stage productions and maximize intelligibility by allowing amplified and live sound to arrive at Listener's ears at approximately the same time.

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The directional characteristics of the loudspeakers will minimize reverberation; these characteristics, the smooth response of the loudspeakers and microphones, the use of narrow-band equalization techniques to suppress the feedback modes of the system, and the frequency shifting feedback stabilizer will control feedback.

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The system allows for connecting of sound effect loudspeakers in a variety of locations, controlled by loudspeaker switches at the sound control position.

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The tape recorder/reproducers and the disc reproducer provided may be used with the sound effect loudspeakers or the central loudspeaker system. The central system can be fed either via the control console high level input channel or independently.

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Microphone receptacles provided will serve for a variety of pickup situations, including front-stage reinforcement, back-stage reinforcement, and sound recording with suspended microphones.

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Gain Control and mixing of all microphones inputs is accomplished by use of a control console with built-in, plug-in preamplifiers, custom-designed to simplify as far as possible the problem of riding gain for theatrical reinforcement.

The playback of motion picture sound is accomplished using the Theater's central loudspeaker system.

Exhibit Hall: The Exhibit Hall System employs ceiling-mounted, 15" loudspeakers distributed at regular intervals in the space. The loudspeakers are divided into three zones, connected to the output of a switching panel. The inputs to this panel, which is located in the Exhibit Hall sound control room, are the outputs of the main mixer-preamplifier, tape recorder, disc player and delay units. For each stage position, the signal to certain designated loudspeakers will be fed through the delay mechanisms to synchronize the arrival of live and amplified sound at the listener's ear. All loudspeakers can be switched off to restrict the coverage to occupied areas.

Control equipment, power amplifiers, and music playback equipment are located in the sound control room. Patching and switching facilities are provided to permit flexibility in the interconnection of equipment and emergency substitution of equipment.

A motion-picture projector may be accommodated using any microphone receptacle in the exhibition area, in conjunction with a matching transformer in the Exhibit Hall sound control room.

The inputs of the tape records can be connected to the outputs of the mixer-preamplifier in order that activities may be recorded.

In addition to the main control console, portable mixer-preamplifiers are provided for local control of the two subdivisions. Input connections from the mixer-preamplifiers are through the wall-mounted microphone receptacles.

Meeting Rooms: The meeting rooms sound amplification system employs a distributed loudspeaker system of eight-inch, ceiling mounted cone loudspeakers for coverage of live activities or playback of recorded material. The system may be used as a single system or divided to allow independent use of the designated separate spaces.

Microphone receptacles are provided as required for each space. The level in each subdivision can be controlled locally or in the main control room.

Control equipment, power amplifiers, and provision for music playback equipment are located in the Activity Building sound system control room. Patching and switching facilities are also provided to permit flexibility in the interconnection of equipment and emergency substitution of equipment.

Portable mixer-preamplifiers are provided to permit any of the subdivisions of the Meeting Rooms to be used independently. Input

centered on ANSI preferred frequencies and applied at any system input.

Meeting Rooms - Distributed Loudspeakers: The overall frequency response of the system shall be within ± 5 dB from 160 to 5,000 Hz, employing as test signals one-third octave band filtered peak noise centered on ANSI preferred frequencies and applied at any system microphone input.

Theater Sound-Effects System: The overall frequency response as measured on the axis of any loudspeaker system shall be within ± 4 dB from 63 to 8,000 Hz, employing as test signals one-third octave band filtered peak noise centered on ANSI preferred frequencies and applied at any system input.

Uniformity of Coverage:

Theatre - Central Loudspeaker Cluster: Levels shall not vary more than ± 4 dB over the entire Theatre seating area, employing as a test signal an octave band of filtered peak noise centered at 4,000 Hz.

Exhibit Hall - Distributed Loudspeakers: Levels shall not vary more than ± 4 dB over the entire Exhibit Hall floor area employing as a test signal an octave-band of filtered peak noise centered at 4,000 Hz.

Exhibit Hall Lobby - Distributed Loudspeakers: Levels shall not vary more than ± 4 dB over the entire Lobby floor area employing as a test signal an octave-band of filtered peak noise centered at 4,000 Hz.

Meeting Rooms - Distributed Loudspeakers: Levels shall not vary more than ± 4 dB over the entire Meeting Room floor area employing as a test signal an octave-band of filtered peak noise centered at 4,000 Hz.

Theatre Sound-Effects System: The system shall be capable of producing broadband peak levels of 98 dB, as read on the sound-level meter, set up for stereophonic playback and measured anywhere in the theatre, with speech and/or music material, without audible distortion, buzzes, or rattles.

MATERIALS

Microphones and Accessories:

Unidirectional Miniature Condenser Microphone: This microphone shall have a cardioid directional characteristic with greater than 15 dB front to back discrimination over the frequency range from 100 to 8,000 Hz, and an on-axis (perpendicular incidence) frequency response within ± 3 dB from 50 to 10,000 Hz. The diameter of the microphone including the preamplifier base shall not exceed 7/8"; the length shall not exceed 5". Sensitivity shall be between -55 dBm and -45 dBm. Each microphone shall be supplied with power supply, shock mount, and 15" of flexible microphone interconnecting cable.

Acceptable: Neumann KM-84 with EA-21 elastic suspension

Quantity: Theater - Five (5)

Total of - Five (5)

Unidirectional Dynamic Microphone: This microphone is intended for general on-stand use for speech reinforcement and in the Theatre for general on-stand or suspended use for general reinforcement, recording, and live sound effects. The microphone shall have a cardioid directional characteristic with greater than 10 dB front-to-back discrimination from 100 to 1,600 Hz, greater than 7 dB front-to-back discrimination from 100 to 8,000 Hz, and an on-axis (perpendicular incidence) frequency response within ± 2.5 dB from 50 to 10,000 Hz. Sensitivity shall be between -60 dBm and -50 dBm. An individual calibration curve shall be furnished with each microphone. Each microphone shall be supplied with a tiltable mount and hardware for floor-stand and desk-stand mounting, and 15' of flexible microphone cable.

Acceptable: Electro-Voice RE-15 or
RCA BK-5B (MI-11010-A) or
Shure SM-53 or
DuKane 7A890

Quantity: Theater - Six (6)
Exhibit Hall - Four (4)
Meeting Rooms - Four (4)

Total of Fourteen (14)

Omnidirectional Dynamic Microphone: This microphone is intended for general hand-held use and as a recording microphone. The microphone shall have an omnidirectional pickup characteristic. The on-axis (perpendicular incidence) frequency response shall be within ± 2.5 dB from 50 to 10,000 Hz. Sensitivity shall be between -60 dBm and -50 dBm. An individual calibration curve shall be furnished with each microphone. Each microphone shall be supplied with a tiltable mount and hardware for floor-stand and desk-stand mounting, and 15' of flexible microphone cable.

Acceptable: Electro Voice RE-55 or
Shure 576 or
DuKane 7A305

Quantity: Theater - Two (2)
Exhibit Hall - Two (2)
Meeting Rooms - Four (4)

Total of Eight (8)

Dynamic Personal Microphone: This microphone is intended to be worn by persons who do not wish to speak from a fixed location. The microphone shall weight not more than 2 ozs., shall have a diameter of not more than $3/4$ " and a length of not more than 3". The on-axis frequency response shall be within ± 2 dB in the range 200 - 2,000 Hz; response at 5,000 Hz shall be ± 4 to ± 8 dB re the response at 1,000 Hz. Sensitivity shall be between -65 dBm and -55 dBm. This microphone shall be equipped with a neck cord and a cable at least 20' long.

Acceptable: AKG D109E with lavalier attachment upside down or
 Shure SM-51 or
 RCA BK - 12A (MI-11024) or
 DuKane 7A815

Quantity: Theater - One (1)
 Exhibit Hall - Two (2)
 Meeting Rooms - Two (2)

Total of Five (5)

Dynamic Close-Talking Microphone: This microphone shall be specifically designed for close-talking applications. It is intended to be used for making announcements from the sound control position. The microphone shall be supplied complete with desk stand and push-to-talk switch.

Acceptable: Electro-Voice 619

Quantity: Theater - One (1)
 Exhibit Hall - One (1)
 Meeting Rooms - One (1)

Total of Three (3)

Microphone System Installation and Accessories: Outputs of all microphones shall be 150-250 ohms, balanced with respect to ground. Microphone mounts and holders shall be supplied by the microphone manufacturer. All cables for microphones specified herein shall be terminated with Cannon XLR-3-12C, Switchcraft A3M, or Amphenol 91-853 connectors. The term "sensitivity" as used herein for microphones and expressed in dBm (dB re 1 mW) is the "effective output level" measured at 1,000 Hz and referred to an rms sound pressure of 10 dynes/cm². The effective output level" rating is based upon the assumption that the microphone works into a load impedance equal to its rated impedance, and is given by the following expression:

$$20 \log E_{10} - 10 \log R_m + .24 \text{ (dBm)}$$

where E_{10} is the open circuit rms microphone voltage at 1,000 Hz in an undisturbed perpendicular incidence plane wave sound field with 10 dynes/cm² rms pressure; and R is the nominal internal impedance of the microphone. The frequency response referred to herein assumes free-field conditions unless otherwise noted.

Microphone Receptacles and Connectors: See Electrical Drawings symbol list for types of receptacle and locations.

Floor receptacles shall be housed in waterproof flush floor boxes with flush caps at least 2-1/8" diameter that lift out and swing open; Soundolier Model MRB or equivalent. Wall-mounted receptacles shall be flush-mounted in metal boxes located 3' above the floor as directed by the Architect. Receptacles for suspended microphones shall be mounted in enclosed boxes fastened to accessible

structure elements as close as possible to the positions indicated on the drawings.

Footlight Microphone Boxes: Microphone receptacles provided for condenser microphones at the front of the stages shall be housed in water-proof, flush, double-outlet floor boxes with flush caps. See elect. dwgs. symbol list for types & locations. Condenser microphone stands shall installed as shown on drawings, using above-specified waterproof flush floor box. The microphone shock mounts shall be affixed to the threaded vertical tubing, allowing the microphones to be installed at approximately eight inches above the stage floor level. The mounting tubes shall be equipped with counter nuts, permitting the microphone base to be fixed at any angle in the horizontal plane. When not in use, the mounting tubes shall be stored in the control room.

Provisions for footlight microphone mounting shall be made at following microphone receptacle positions:

Theater #2 through #6:

Condenser Microphone Power Supplies: With condenser microphones used at the footlight microphone position, the condenser microphone power supply shall be mounted in the sound control room equipment rack, with input and output connections to the patch panel arranged to permit use of any microphone line with any console input.

Acceptable: Neumann NK-48

Quantity: Theater - One (1)

Total of One (1)

Microphone Desk Stands: Microphone desk stands shall be chrome with flat-painted base, shall support the microphone 4 to 8 inches above a table, and shall weigh at least 1½ lbs.

Acceptable: Altec-Lansing 26A or
Electro-Voice 422 or
RCA MI-11021-3 or
Atlas DS-10

Quantity: Theater - Two (2)
Exhibit Hall - Three (3)
Meeting Rooms - Six (6)

Total of Eleven (11)

Microphone Floor Stands: Microphone floor stands shall be chrome with flat-painted base, shall be adjustable from 37" to 64" in height, and shall weigh at least 13 lbs.

Acceptable: Altec-Lansing 22C or
RCA MI-11021-8 or
Atlas MS-20

Quantity:	Theater - Four (4)	5
	Exhibit Hall - Six (6)	6
	Meeting Rooms - Twelve (12)	7
	Total of Twenty-Two (22)	9

Microphone Quick-Disconnect Isolation Mounts: Microphone quick-disconnect isolation mounts shall be metal units with molded rubber inserts, designed to fit between a microphone holder and a desk stand or floor stand. They shall provide vibration and shock isolation and shall permit instant, noiseless removal of the microphone from the stand for hand-held use.

Acceptable: Shure A47 17

Quantity: Ten (10) 19

Microphone Lines: All microphone receptacles shall be connected by individual lines to the control room patch panel. Microphone lines shall be run in conduit and shall be Belden #8672 or equivalent.

Microphone Flexible Cables: Flexible extension cables shall be supplied for the microphones. Each flexible extension cable shall be fitted at one end with a connector as specified hereinbefore for microphone cables and at the other end with a mating connector. Flexible cables shall be Belden #8412 or Birnbach #772.

Quantity:	10'	25'	40'	75'	
Theater	6	6	20	8	34
Exhibit Hall	6	6	6	-	36
Meeting Rooms	6	6	6	-	38

Special Adapter Cables: Special adapter cables shall be provided to allow connection of portable motion picture projector's sound output to any microphone receptacle. Also, install an input pad in the microphone patch panel as shown on Drawings.

Acceptable Cables: 45

Four (4) Switchcraft 3501F to Cannon XLR-3-12C or Switchcraft A3M 47

Two (2) Switchcraft 3501F to Cannon XLR-3-11C or Switchcraft A3F 49

Two (2) Switchcraft C-270 to Cannon XLR-3-12C or Switchcraft A3F 51

Two (2) Standard Switchcraft C-260 to Cannon XLR-3-11C or Switchcraft A3F 53
Switchcraft A3F 54

Two (2) Switchcraft 740 to Cannon XLR-3-11C or Switchcraft A3F 56
(for Ampex AG440) 57

Length of all cables - 20 ft. 58

Control Equipment:

Portable Mixer-Preamplifier: The portable mixer-preamplifiers shall be provided for use in the Exhibit Hall and Meeting Rooms to meet the functional requirements. These units shall be provided with a carrying case and five strain-relieved cables ten feet in length, equivalent to Belden 8762 terminated at one end to mate with the four microphone inputs and line output of the preamplifier, and terminated at the other end with connectors as hereinbefore specified for microphone cables.

Four microphone-level inputs and one line-level output shall be provided. A VU meter shall be provided. The mixer-preamplifier shall be a transistorized unit, factory assembled and tested and shall meet the following performance requirements:

Gain:	88 dB or greater	20
Output Level:	+18 dBm or greater at less than 2% total harmonic distortion at all frequencies between 100 and 10,000 Hz.	22 23 24
Output Impedance:	150-250 ohms, ungrounded	26
Input Impedance:	150-250 ohms, ungrounded	28
Frequency Response:	Within \pm 1.0 dB, from 30 to 15,000 Hz.	30 31
Equivalent Input Noise:	-120 dBm maximum	33
Acceptable:	RCA BN-17A (MI-141400-A) <u>or</u> DuKane 2A75	35 36
Quantity:	Exhibit Hall - Two (2)	38
	Meeting Rooms - Two (2)	40
	Total of Four (4)	42

Fixed Mixer-Preamplifier: Permanently mounted mixer-preamplifiers shall be located as shown on drawings. The units shall be capable of being removed from their normal positions for servicing.

Four microphone-level inputs and one line-level output shall be provided. One VU meter shall be provided for each mixer-preamplifier. The switched speech equalizer can be mounted on the mixer-preamplifier or be rack mounted.

The mixer-preamplifier shall be a transistorized unit, factory assembled and tested and shall meet the following performance requirements:

Gain:	88 dB or greater	5
Output Level:	+18 dBm or greater or less than 2% total harmonic distortion at all frequencies between 100 and 10,000 Hz.	7 8 9
Output Impedance:	150-600 ohms, ungrounded	11
Input Impedance:	150-200 ohms, ungrounded	13
Frequency Response:	Within ± 1.0 dB, from 30 to 15,000 Hz.	15 16
Equivalent Input Noise:	-120 dBm maximum	18
Acceptable:	Altec Lansing 1592A <u>or</u> RCA BN-17-A (MI-141400-A) DuKane 2A75	20 22 24
Quantity:	Exhibit Hall - Two (2)	26
	Total of Two (2)	28

Theater Custom Control Consoles:

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General Requirements: Two control consoles, one for sound reinforcement and one for sound effects, shall be custom built to fulfill the functional requirements as specified hereinbefore and shown on the functional diagram on drawings. The consoles shall have the following mixing controls: For sound reinforcement - three high-level, eight microphone, two master; and for sound effects - fourteen individual and two master controls.

The control consoles shall be built and supplied complete by the manufacturer of the plug-in amplifiers used in the console, or shall be built under the manufacturer's supervision by his authorized representative.

Test records including frequency response curves and measured gain, using each input and output channel, shall be supplied with the consoles. These documents shall be included in the instruction book containing the technical descriptions of the system's components, which shall be filed with the Owner. Prepare a shop drawing, showing finish materials, electrical interconnections, proposed components and console housing for architects approval before commencing fabrication and installation of the consoles. The control panel layouts are shown on Drawings. The arrangement shown is essential to the ease of system operation for theatrical reinforcement; the dimensions shall be kept at a minimum for installation of the components. The slope of the control panel surfaces containing vertical attenuators shall be maintained at 15 to 20 degrees above the horizontal.

operating positions)

Source Impedance: Microphone: nominal 150 ohms
ungrounded

High-level inputs: 600 ohms
ungrounded.

Load Impedance: 600 ohms ungrounded

Crosstalk, measured at output of any channel with +18 dBm

Power Source: 120 V.A.C., 60 Hz

Acceptable Control Console Components:

Preamplifiers and Booster Amplifiers

Altec Lansing 9470A or

RCA BA-71C or

Langevin AM-16 (socket strapped for +18 dBm)

Note: All sockets for preamplifiers and booster amplifiers shall be strapped for nominal 150 ohm input. All pre-amplifiers and booster amplifiers shall be connected for 600 ohm output.

Quantity: Ten (10) - sound reinforcement console

Line Amplifiers:

Altec Lansing 9470A or

RCA BA-73c (with external strapping reducing gain to 45 dB) or

Langevin AM-16 (socket strapped for +24 dBm)

Note: Line amplifiers shall be connected for 600 ohm input and output.

Quantity: Two (2) - sound reinforcement console

Seven (7) - sound effects console

Total of Nine (9)

Power Supply and Amplifier Mounting Equipment: Power supply shall be provided, in accordance with the manufacturer's recommendations. Plug-in mountings for the console amplifiers and power supply shall be supplied by the manufacturer of the amplifiers.

Single-Gang Vertical Attenuators: Unbalanced ladder, straight-line type, stepped mixer attenuators shall be provided for each channel and as master gain controls. Attenuators shall have at least 30 steps; attenuation shall increase no more than $1\frac{1}{2}$ dB per step within the normal operating range and the attenuation curve shall be tapered to infinity.

Mixer Circuit Unequal-Impedance-Ratio Type Sound Reinforcement Console:

Mixing resistors shall be provided to connect the input channel attenuators to the mixing buses as shown on the functional diagram.

Acceptable: 1/2 W 5% composition resistors soldered to fixed connection points at each end.
Value as shown.

Dividing Networks and Mixing Networks Sound Effects Console: Dividing networks and mixing networks shall be installed as shown on Drawings. These shall be balanced standard networks manufactured by Altec Lansing, Daven, or Langevin, or custom assembled networks employing non-inductive 5% resistors mounted on terminal boards, with the circuits approved by the acoustical consultants prior to installation.

Switched Equalizer: A switched equalizer shall be provided as shown on the functional diagrams. The equalizer switch shall be located on the sound reinforcement control panel as shown on Drawings. Equalizer components shall be connected as shown in detail D of Drawings. The equalizer shall include positions labeled "FLAT" providing no equalization, "200 Hz" providing a roll-off of 6 dB per octave below 300 Hz, and "300 Hz STEEP" providing a roll-off of at least 12 dB per octave below 300 Hz. The equalizer is intended to improve intelligibility and help control feedback and should be set in the position which provides the best naturalness and intelligibility for the person or event being reinforced.

Acceptable components:

Switch: Daven or Langevin precision instrument switch.

"Steep" Filter: UTC HML300 or

Altec Lansing 9066A 300 Hz

Other Filters: 1/2 W + 5% resistors and + 10% tubular Mylar capacitors as shown.

Pushbutton Switches: Pushbutton switches shall be installed in the control consoles as indicated in Drawings. Each station shall have the push-buttons interlocked so that no two buttons may be engaged at one time. Buttons shall not be electrically illuminated.

Acceptable: Switchcraft Series 35,000

Quantity: As required.

Control Desk: See Section 6B for desk to support and mount the control consoles and the recessed control units.

Single Microphone Control Unit: Three single-microphone control units shall be provided for the Meeting Room system as shown on Drawings. The preamplifiers shall be rack-mounted and each unit shall be provided with a rack-mounted VU meter. Inputs and outputs shall be connected to low and high-level patch panels. The speech equalizer switch shall be mounted below the VU meters. Power supplies by the manufacturer of the preamplifiers shall be provided.

Acceptable Components:

Preamplifiers: Altec Lansing 9470A or

RCA BA-71C or

Langevin AM-16

Quantity: Six (6)

VU-Meters: API 561 VU-Meter, A Scale or

Simpson 1349 VU-Meter, with

1123 half bezel, A Scale or

Triplett 4500 VU-Meter with
half bezel, A Scale

Quantity: Three (3)

Speech Equalizer: As shown on Drawings.

Quantity: Total of Three (3) complete units.

Tape Recorder/Reproducer (Single Channel): The tape recorder/reproducer shall be capable of handling 7" tape reels at playing speeds of 7-1/2" and 3-3/4" per second. Frequency response shall be within +2 -4 dB from 30 to 15,000 Hz at 7-1/2 i.p.s. and within +2 -4 dB from 40 to 8,000 Hz at 3-3/4 i.p.s. The unweighted noise level (including all noise components from 30 to 18,000 Hz) shall be -55 dB or better at 7 1/2 i.p.s.

with reference to a recording level at which total harmonic distortion does not exceed 3% with a 400 Hz test signal. The machine shall have half-track and quarter-track heads and shall reproduce full or half-track heads and shall reproduce full or half-track monophonic and quarter-track stereophonic tape recordings and make monophonic half-track recordings. Simultaneous recording and playback shall be possible. Flutter and other speed variations shall be held to within 0.1% tolerance at 7-1/2 i.p.s. The machine input shall provide balanced bridging of a 600-ohm line; output shall be 600 ohms, ungrounded, at +4 dBm. Start, stop, record, fast forward and rewind controls shall be relay operated to allow full remote control. A pushbutton-type, remote control panel wired and supplied by the manufacturer of the machine shall be mounted on the control desk. The tape recorder/reproducers shall be rack-mounted and connected as shown on the functional diagrams, Drawings.

Acceptable Tape Recorder/Reproducer:

Ampex AG-500-1, #4010048-08 with remote control and factory installed quarter-track head.

Quantity: Exhibit Hall - Two (2) complete tape recorder/reproducers

Meeting Rooms - One (1) complete tape recorder/reproducer

Tape Recorder/Reproducer (Dual Channel): The tape recorder/reproducer shall be capable of handling 7" tape reels at playing speeds of 7 1/2" and 3-3/4" per second. Frequency response shall be with + 2 dB from 40 to 10,000 Hz at 7 1/2 i.p.s. and within +2 dB from 50 to 7,500 Hz at 3-3/4 i.p.s. The unweighted noise level (including all noise components from 30 to 18,000 Hz) shall be -60 dB or better at 7 1/2 i.p.s. with reference to a recording level at which total harmonic distortion does not exceed 3% with a 400 Hz test signal. The machine shall have separate dual half-track erase, record, and playback heads and a dual quarter-track playback head.

It shall reproduce full-track, half-track and quarter-track monophonic tape recordings, and dual half-track and dual quarter-track stereophonic recordings. It shall make monophonic half-track recordings or stereophonic dual half-track recordings. Simultaneous recording and playback shall be possible. Flutter and other speed variations shall be held to within 0.1% tolerance at 7 1/2 i.p.s. The machine inputs shall provide balanced bridging of 600-ohm lines; outputs shall be 600 ohms, ungrounded, at +8 dBm. Start, stop, record, fast forward and rewind controls shall be relay operated. The recorder/reproducer shall be mounted in the sound control desk in the Theater sound control room. The tape recorder shall be mounted with the top panel sloping 15° above the horizontal towards the operator. The tape recorder/reproducer shall be connected as shown on the functional diagram, Drawings.

Acceptable Tape Recorder/Reproducer:	5
Ampex AG-500-2, #4010049-06	7
Quantity: Theater - One (1) complete recorder/reproducer -	9
sound reinforcement console.	10
Two (2) complete recorder/reproducers sound	12
effects console	13
<u>Disc Reproducing Equipment:</u> The disc reproducer shall be capable of	15
reproducing monophonic or stereophonic records, and shall consist of	16
a turntable, arm, cartridge, and equalized preamplifier. The system	17
shall meet the NAB disc reproducing standards of March 1964.	18
<u>Turntable:</u> The turntable shall use a hysteresis-synchronous motor	20
and shall operate at 33-1/3 and 45 r.p.m.	21
Acceptable: Empire 598. <u>or</u>	23
Gates CB-77. <u>or</u>	25
Thorens TD-125	27
<u>Tone Arm:</u> The tone arm shall be a 12" dynamically balanced unit with	29
plug-in head and shall be mounted on the turntable according to	30
manufacturer's instructions.	31
Acceptable: Shure M-232 <u>or</u>	33
Rek-O-Kut S-320	35
<u>Cartridge:</u> The cartridge shall be a high-compliance stereo unit with a	37
0.7 mil conical stylus, designed to operate into a 47k ohm load.	38
Acceptable: Shure M44-7 <u>or</u>	40
Pickering VL5/AT-3	42
<u>Equalized Preamplifier:</u> The preamplifier shall be a transistor stereo-	44
phonic unit, mounted so that cables from the tone arm are not longer	45
than four feet; and controls are convenient to the operator. Controls	46
shall include on-off switch, volume, balance, bass boost and cut,	47
treble boost and cut, stereo-mono switch; and high-frequency rolloff.	48
Each channel of the preamplifier shall meet the following performance	49
requirements:	50
Frequency Response: \pm dB from 30 to 15,000 Hz with reference to the	52
RIAA playback curve, with all controls in "flat" position.	53
Bass Tone Control Range: \pm dB at 30 Hz	55
Treble Tone Control Range: \pm dB at 10,000 Hz	57

High-Frequency Rolloff: Choice of none or rolloff of at least 12 dB
per octave with turnover frequency of 7,000 Hz 5
6

Gain: At least 0dBm output for 3mV input at 1,000 Hz 8

Harmonic Distortion: Less than 0.5% at +4 dBm output, 10
from 30 to 15,000 Hz 11

Hum and Noise: At least 60 dB below +4 dBm output, with input shorted 13

Input Impedance: 47,000 ohms 15

Output Impedance: 600 ohms or less 17

Stereo-Mono Switch: In the mono position, this shall tie the two 19
channels together. The unit shall be modified 20
by shorting out the 7,500 ohm "bland" resistor in 21
accordance with the manufacturer's directions 22
provided in the instruction manual, to achieve 23
this requirement. 24

Acceptable Preamplifier for Stereo or Mono Operation: Dynaco PAT-4 26

Acceptable Preamplifier for Mono Only Operation: 28

Dynaco PAT-4 with the two "low" phone input jacks paralleled to 30
provide a mono signal directly from the cartridge, with all 31
controls not pertinent to single-channel operation removed or 32
capped, and with a UTC A 20 transformer connected for 600 ohms to 33
600 ohms connected to the output of the channel in use to provide 34
ungrounded output. 35

Mounting of Disc Reproducer: The disc reproducers shall be control- 37
desk mounted and provided with recommended resilient mounting. 38

Note: A label with the legend, "DISENGAGE IDLER WHEN POWER IS OFF," 40
clearly printed, shall be affixed to the turntable next to the speed 41
control lever. 42

Quantity: Theater - One (1) complete unit (Stereo) 44

Exhibit Hall - One (1) complete unit (Mono) 46

Total of One (1) stereo and One (1) mono 48

FM-AM Tuner: The FM-AM tuner shall employ only solid-state devices, 50
with field-effect transistors in the front-end circuits, and shall be 51
equipped with a tuning meter. The tuner shall be supplied with rack- 52
mounting hardware. An external FM antenna and rotor shall be provided. 53
The rotor control shall be rack-mounted adjacent to the tuner. 54

The tuner shall receive the standard AM and FM broadcast bands and shall 56
meet the following performance characteristics. 57

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FM Sensitivity: 2 microvolts for 30 dB quieting	5
FM Selectivity: 250 KHz at -6 dB; 820 KHz at -60 dB	7
FM Capture Ratio: 2 dB	9
FM Total Harmonic Distortion: less than 0.5% at 100% modulation	11
FM Cross Modulation Rejection: -95 dB	13
FM Rejection of AM: -55 dB	15
FM Hum and Noise: -70 dB re 100% modulation level	17
FM Stability: +10 KHz	19
FM Frequency Response: +2 dB, from 30 to 15,000 Hz	21
AM Sensitivity: 2 microvolts	23
AM I.F. Bandwidth: 7 kHz	25
AM I.F. Rejection: 64 dB	27
AM Image Rejection: 86 dB	29
Output Capability: At least 0dBm into a 600 ohm load at 0.5% total harmonic Distortion	31 32
Acceptable:	34
Tuner: Sherwood S-2500 (rack mount, 600 ohm output) with UTC A-20 output transformer connected for 600 ohms to 600 ohms	36 37
Antenna: JFD LPL-FM6	39
Rotor: Cornell-Dubilier AR-22 <u>or</u> Alliance C-225	41 42
Quantity: Exhibit Hall - One (1) Complete Unit	44
<u>Power Amplifiers and Associated Equipment:</u>	46
<u>Power Amplifiers:</u> The power amplifiers shall employ solid-state devices (transistors) throughout and shall include positive protection of circuit components in the event of input overdrive and/or output overload and/or short circuit. Protective circuits shall withstand overdrive up to 10 dB and/or short circuited output for 1/2 minute without causing blown fuses. Manual reset protective circuits are acceptable if they are resettable from the front panel. The amplifiers shall have input level controls.	48 49 50 51 52 53 54 55
The power amplifiers shall be rack-mounted in the sound control rooms.	57

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The outputs shall be connected for 70 volt operation. The amplifiers shall meet the following performance requirements:

Frequency Response: Within ± 1 dB from 30 to 15,000 Hz at 10 dB below nominal output power capability

Power Output: As specified hereinafter at 70-volt output, with less than 2% total harmonic distortion at all frequencies from 30 to 15,000 Hz. Distortion shall not increase at lower power output and/or less than full load.

Source Impedance: 600 ohms, ungrounded

Input Sensitivity: An input of -7 dBm shall produce rated output power

Output Regulation: Within 3 dB from no load to full load; amplifier shall be stable under "no-load" conditions.

Noise: At least 80 dB below rated output with input shorted.

Power Supply: 117-volt (nominal), 60 Hz a.c.

200-Watt Power Amplifiers:

Acceptable: Altec Lansing 1590B or

Rauland DX 250 or

DuKane 1A921

Quantity: Sixteen (16)

(Amplifiers #1 through 12, 14, 15, 17 and 27)

100-Watt Power Amplifiers:

Acceptable: Altec Lansing 1594A or

Rauland DX 125 or

DuKane 1A911

Quantity: Six (6)

(Amplifiers 16, 21, 22, 28, 29, 30)

50-Watt Power Amplifiers:

Acceptable: Altec Lansing 351C or

C/N Laboratories Model 35 MRM with audio lockout, IT input transformer and 70-volt output transformer or

Langevin AM 50AT with BR-4402 input unit or

DuKane 1A901

Quantity: Fourteen (14)

5

(Amplifiers #13, 18, 19, 20, 23-26 and 31-36)

7

Power Amplifier Monitor Jack and Volume Indicator: A VU-meter, monitor jack and rotary selector switch shall be rack-mounted in the Exhibit Hall and Meeting Room systems to permit monitoring the outputs of the various power amplifiers. As shown in the functional diagram, the selector switch shall connect the monitoring equipment alternately to the 70-volt outputs of the various power amplifiers in the system. The switch shall be a two-pole unit with non-shorting contacts. The switch output shall feed the VU-meter circuit and monitor jack through a voltage divider network consisting of an 18,000-ohm, 1-watt series resistor and a 680-ohm shunt resistor. These resistors shall be trimmed as necessary such that an amplifier output of 22.4-volt produces a reading of "0" on the VU-meter. A range-extender switch and 10 dB pad shall also be provided for the VU-meter so as to permit an "0" reading at full 70-volt amplifier output. The meter shall have a scale length of approximately four inches. The meter, selector and extender switches and monitor jack shall be mounted in close proximity on a rack panel in a clearly visible location.

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Acceptable Meters: API 561 VU-Meter, A Scale or

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Simpson 1349 VU-Meter, A Scale or

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Triplett 450G VU Meter with half bezel, A Scale

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Quantity Complete Assemblies: Two (2)

33

(One each for the Exhibit Hall
and Meeting Rooms)

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Emergency Switching: Rack-mounted "normal-emergency" switches and associated relays shall be provided to allow for rapid substitution of power amplifiers in case of amplifier failure, as shown on drawings. The switches shall transfer the loudspeaker loads and control power to the relays; the relays shall transfer the incoming signals to the power amplifiers. Switches shall be 3PDT toggle switches.

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Relays shall be mercury-wetted contact, DPDT, fully encapsulated type, installed in accordance with manufacturer's recommendations. Twenty-four v.d.c. power for operation of the relays shall be provided by power supplies such as Precise Measurement Company, Model AF-25 (Flemington, N.J.)

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Acceptable Relays: C.P. Clare HG2A-1002 or

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Adams and Westlake Co. MW-2603-21 or

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Potter and Brumfield JM 2-107

55

Quantity: Twenty-Seven (27)

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Exhibition Hall Power Amplifier Switching Arrangement: Pushbutton switches shall be provided as shown on drawings for connection of certain designed loudspeakers to the appropriate delay channel. The pushbutton switches shall be rack-mounted and installed on a brushed aluminum panel with all markings engraved and filled in black, except the note above the switches which shall be filled in red.

Switches shall be vertically interlocked and shall have a lock-out feature so that no two buttons vertically may be engaged at one time. The buttons shall not be electrically illuminated. Rating shall be 5 amp minimum.

The amplifier outputs and the loudspeaker lines shall be installed in a conveniently located and clearly marked terminal board to allow changes in the connections.

Acceptable Switches: Switchcraft Series 35000.

Power amplifier output/loudspeaker connections are as follows:

Stage Positions:

No. 1:

Amp. No.

Speaker No.

1	3, 6, 12, 13
2	7, 14, 15, 21, 22
3	2, 10, 11, 19, 20
4	1, 9, 17, 18, 26, 27
5	8, 16, 23, 24, 28, 29
6	25, 30, 31, 32, 33
7	45, 46, 47
8	34, 35, 36, 37
9	41, 42, 48, 49, 50, 51, 52
10	38, 39, 40, 43, 44
11	53, 54, 55, 56, 57, 58

No. 2

Amp. No.

Speaker No.

1	3, 6, 12, 13
2	7, 14, 15, 21, 22
3	2, 10, 11, 19, 20
4	19, 17, 18, 26, 27
5	8, 16, 23, 24, 28, 29
6	25, 30
7	31, 32, 33, 34
8	35, 36, 37, 38, 39
9	40, 41, 42, 43, 44
10	45, 46, 47, 48, 49
11	50, 51, 52, 53, 54
12	55, 56, 57, 58

No. 4

No. 3.

Speaker No.

1	32, 37, 46, 48
2	31, 35, 36, 40, 41
3	47, 49, 50, 52, 53
4	34, 38, 39, 44
5	54, 55, 56
6	42, 43, 57, 58
7	1, 2, 3, 4, 5
8	6, 7, 8, 9, 10
9	11, 12, 13, 14, 15
10	16, 17, 18, 19, 20
11	21, 22, 23, 24, 25
12	26, 27, 28, 29, 30

Speaker No.

1	32, 33, 36, 40
2	31, 35, 39, 43, 44
3	45, 46, 47, 48, 49
4	34, 38, 42
5	50, 51, 52, 53, 54
6	55, 56, 57, 58
7	1, 2, 3, 4, 5
8	6, 7, 8, 9, 10
9	11, 12, 13, 14, 15
10	16, 17, 18, 19, 20
11	21, 22, 23, 24, 25
12	26, 27, 28, 29, 30

<u>No. 5</u>	<u>Speaker No.</u>	
1	45, 46, 49, 52, 53	5
2	47, 50, 54, 56 57	7
3	31, 32, 33, 34	8
4	51, 55, 58	9
5	35, 36, 37, 38, 39	10
6	40, 41, 42, 43, 44	11
7	1, 2, 3, 4, 5	12
8	6, 7, 8, 9, 10	13
9	11, 12, 13, 14, 15	14
10	16, 17, 18, 19, 20	15
11	21, 22, 23, 24, 25	16
12	26, 27, 28, 29, 30	17
		18

Other Rack-Mounted Equipment:

Equipment Racks: All equipment specified as rack-mounted shall be mounted in enclosed, ventilated equipment racks located as shown on the drawings. Equipment racks shall be constructed of 16 gauge (minimum) cold rolled steel and shall have rear doors and square front vertical corners. Rack dimensions shall not exceed 22-1/2" wide by 18-1/2" deep by 83" high. Any unused panel space shall be filled in with blank solid or ventilating panels. Patch panels shall be located at least 30" above the floor.

Each rack shall be equipped with permanently mounted 110 v.a.c. 3-conductor grounded stripline rated for 20 amp., with outlets on 6" centers, extending the height of the rack and with interior incandescent illumination connected thereto for ease in servicing and connecting the installed components.

Audio Line Cabinets: Each control room shall be provided with wall-mounted steel cabinets for incoming and outgoing lines. Separate cabinets shall be provided for: a) the microphone and line-level lines and b) the loudspeaker lines. All lines shall be terminated in strip termination blocks, having enough connection points for all lines plus 30% spare.

All lines between the line cabinets and the equipment racks shall be in steel conduit.

Patching Facilities: Patch panels and shielded patch cords shall be supplied to fulfill the requirements shown on the functional diagram. Patch panel jacks shall be "normaled through" where shown. Jack details are shown on Drawings. All jacks shall be clearly labeled, and jacks shown in close proximity on the functional diagram shall be vertically adjacent. Designation strips shall be lightly colored to differentiate between: Microphone lines, console (mixer-preamplifier) inputs, line-level connections, power amplifier inputs, and power amplifier monitor outputs.

Acceptable Jack Strip: ADC Products PJ-393 or RCA MI-11666 or 5
 RCA MI-11666 or Switchcraft 1200, with MT-3348 jacks 6
or Trimm 96-71 7

Quantity: As required. 9

Acceptable Patch Cords: ADC Products PJ-82 or RCA MI-4652-D2 or 11
 Switchcraft 18QD18 or Trimm 841-2-PP 12

Quantity: Exhibit Hall - Fifteen (15) 14
 Meeting Room - Fifteen (15) 15
 Theater - Twenty (20) 16
 Total: Fifty (50) 17

Fixed Equalization: Drawings indicate the position and detail of suggested 19
 fixed equalization to compensate for the response of the horn loudspeakers. 20
 Values of components may require changing as a result of measurements 21
 performed by the contractor and/or acoustical consultant, to meet perfor- 22
 mance requirements. 23

Automatic Level Control: The automatic level control shall be used to 25
 limit the dynamic range of program material and to lessen the need for 26
 manual level adjustments. The unit shall be a solid-state device with 27
 frequency response \pm dB from 50 to 15,000 Hz. Total harmonic distortion 28
 shall not exceed 1% at +16 dBm output. The output noise level shall be 29
 below -60 dBm at normal gain. The unit shall be capable of +10 dB of 30
 gain control and relative gain shall be indicated by a zero-center meter 31
 on the front panel. 32

Input and output impedances shall be 600 ohms ungrounded and maximum gain 34
 shall be 50 db. The unit shall employ memory circuits so that gain level 35
 will be a function of both input and average levels and shall employ logic 36
 circuits to hold gain constant during pauses in program material and not 37
 return gain to zero until 10 seconds of lapse in program have occurred. 38

Acceptable: CBS Laboratories Audimax III, Model 444. 40

Quantity: Exhibit Hall - Two (2) 42

Tape Delay Units: The tape delay units shall be rack mounted in the sound 44
 control room as shown on Drawings. The delays shall be spaced consecu- 45
 tively at intervals of 30 milliseconds. The units shall meet the following 46
 performance requirements. 47

Voltage: 0 dB 49

Maximum output level: Not less than 0 dbm at 2% total harmonic 51
 distortion at all frequencies between 40 and 52
 10,000 Hz. 53

Frequency response: 60 to 10,000 Hz, +2 db. 55

Signal-to-noise ratio: at least 48 dB at 400 Hz at 3% total harmonic distortion. 5
6

Source and load impedances: 600 ohms ungrounded. 8

Wow and flutter: less than 0.3% 10

Acceptable unit: Philips delay machine type EL6911/02 with five tape loops. 11
12
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Quantity: Exhibit Hall - One (1) with two additional playback heads and preamplifiers. 15
16

Six delays simultaneously and separately available, range 30 to 180 msecs. 18
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Acceptable Supplementary Preamplifiers: Viking PB10-22 21

Quantity: Two (2) 23

High-Impedance Bridging Input Transformer: This transformer shall be provided to allow connection of any portable "home-high-fidelity" tape-playback, AM or FM tuner, or phonograph with either crystal cartridge or magnetic cartridge with preamplifier, to any microphone input of the mixer-preamplifier. The input (labelled secondary) shall be connected to screw terminals on the front of the equipment rack, via a 30 dB pad, with the shield connected to a separate (third) terminal and also connected to system ground and the transformer case. The output (labelled primary) shall be connected to a jack on the patch field. The transformer shall meet the following specifications. 25
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Input Impedance (Rated) - 50,000 ohms 37

Output Impedance Between 200 ohms and 250 ohms 39

Frequency Response - Within +1 dB, 30-15,000 Hz 41

Maximum Level - 5 dBm or greater 43

Acceptable: United Transformer Co. A-11 45

Quantity: Two (2) 47

Loudspeakers and Associated Equipment: 49

Location and Orientation of Loudspeakers: The loudspeakers shall be located and oriented as shown on drawings. 51
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Mounting of Theater-Type Loudspeakers: The contractor shall mount the theater-type loudspeakers on special frames. The contractor shall attach the loudspeakers to the frames in such a way that each unit will have a 10° horizontal and vertical adjustability and will maintain its precise 54
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location and orientation after the system has been adjusted. Special care shall be taken to locate the drivers of the different loudspeakers as equidistant as possible from listeners in the zones of overlapping coverage to avoid phase interference. All loudspeakers shall be mounted as close together as possible.

No obstructions larger than 1/2" diameter shall be permitted in front of high-frequency horns. Shop drawings of the proposed loudspeaker assembly shall be prepared for review of the Architect and Acoustical consultant **before fabrication. Finish of** all central loudspeaker components shall be flat black unless directed by the Architect.

Block and tackle may be used only to hoist the equipment into place during initial installation; but not to hold the systems in place after completion of the installation.

Theater-Type Loudspeaker Systems: The central loudspeaker cluster shall consist of direct radial-expansion (sectoral) high-frequency exponential horn loudspeakers and one low-frequency exponential horn loudspeaker specifically providing the required directional characteristics with adequate efficiency and smoothness of frequency response to permit the system to meet performance requirements.

Equipment is specified below by manufacturer and type number. All theater-type loudspeaker components shall be by one manufacturer.

Standards for measurement of loudspeaker directional characteristics are currently non-existent, but alternate loudspeaker systems may be considered for approval if free-field (anechoic) frequency response measurements, employing continuous pure-tone signals, measured with calibrated microphones a minimum of 14 ft. from loudspeaker, and measured on-axis and at 5-degree increments in both horizontal and vertical planes to 90-degrees off axis, then 10-degree increments to 180-degrees are submitted with contractors' proposals. The following types of loudspeaker systems shall not be considered as substitutes for equipment specified:

Re-entrant, diffraction, or folded horn loudspeakers (because of inherent "peaky" frequency response on-axis or off-axis and lack of directional control);

Loudspeaker arrays employing any series or series-parallel loudspeaker connections (because of additional phase-shift at high frequencies when loudspeakers are driven by high-impedance source);

Line-source or column loudspeakers employing only one line of cone-type loudspeakers, or one high-frequency and one low-frequency line of cone-type loudspeakers (because single "lines" can control directional characteristics in only one plane, not two).

Loudspeaker systems less sensitive than those specified or with lower power handling capacity. (See appropriate EIA and IRE Standards.)

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The level matching transformer and crossover network shall be rack mounted in the control room with loudspeaker lines as shown on the functional diagram running to the loudspeaker system.

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Acceptable loudspeaker components and quantities shall be as follows:

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High-Frequency Horns:

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Acceptable: Altec Lansing 311-90 or

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James B. Lansing 2350 with 2328 throat or

19

RCA MI-9595 with MI-11428 throat

21

Quantity: Three (3)

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High Frequency Drivers:

25

Acceptable: Altec Lansing 291-16A or

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James B. Lansing 2440 or

29

RCA MI-11427

31

Quantity: Three (3)

33

Low-Frequency Enclosure: (Long dimension horizontal)

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Acceptable: Altec Lansing 211A or

37

James B. Lansing 4550 or

39

RCA MI-9462

41

Quantity: One (1)

43

Low Frequency Loudspeakers:

45

Acceptable: Altec Lansing 515B or

47

James B. Lansing 2220B or

49

RCA MI-11421

51

Quantity: Two (2)

53

Crossover Network:

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Acceptable: Altec Lansing N-500F or

57

COMMUNITY CENTER COMPLEX - SAC

James B. Lansing 3150 or

RCA MI-11422

Quantity: One (1)

Matching Transformer:

Acceptable: Altec Lansing 15067 or

DuKane 710-2134 or

RCA MI-9472B

Quantity: Two (2)

Connect matching transformer as follows:

Transformer #1

	Altec Lansing	DuKane	RCA	
	15067	710-2134	MI-9472B	
High-Frequency Level	with AL	with JBL	with RCA	
Matching Transformer:	Loudspeakers	Loudspeakers	Loudspeakers	
HF crossover	1 + 4	A + J	S + 15	
network terminals:				
HF Driver No. 1 (rear)	1 + 3	A + G	S + 7.5	
HF Driver No. 2 (middle)	1 + 2	A + D	S + 3.75	
HF Driver No. 3 (front)	3 + 4	A + B	S + 1.87	

Transformer #2

LF crossover network	1 + 4	A + J	S + 15	
terminals:				
LF Loudspeakers	1 + 3	A + G	S + 7.5	
in parallel				

Exhibit Hall Loudspeakers:

Fifteen-Inch Loudspeakers

The fifteen-inch loudspeakers shall employ separate voice coils for low and high frequencies. The on-axis sensitivity (EIA) shall not be less

than 47 dB. The on-axis frequency response shall be within 8 dB (+ 4dB) to 8,000 Hz. Response 30 degrees off axis shall be within 6 dB of the on axis response over this frequency range. Power handling capacity shall be 35 watts minimum.

Acceptable: Altec Lansing 605B or

Jensen G-600

Quantity: Total of Fifty-eight (58) (Exhibit Hall 1-58)

Loudspeaker Matching Transformers for 15" Loudspeakers

The matching transformers shall be firmly affixed to the transformer mounting bracket on the loudspeaker frame. Loudspeaker matching transformers shall be connected as shown on the functional diagram.

Acceptable: Altec Lansing 15066 or

Jensen ZC-100

Quantity: Fifty-Eight (58)

Loudspeaker Enclosures for 15" Loudspeakers

The fifteen inch loudspeakers in the Exhibit Hall shall be ceiling mounted in custom-built wooden enclosures as shown on Drawing N-6. The sound-transparent facing in front of the loudspeakers shall not be less than 40% open. If perforated metal is used, the diameter of the perforation shall be not less than 1/8". All interior surfaces shall be covered with a 1" blanket of glass fiber 1-1/2 to 3 lbs./cu. ft. density. A sample enclosure shall be submitted to the Architect for approval before the contractor commences installation.

Acceptable: Custom built enclosure as per Drawing N-6.

Quantity: Fifty-Eight (58)

Distributed Loudspeaker Systems:

Eight Inch Loudspeakers

Eight inch loudspeakers shall employ separate low-frequency and high-frequency cones and voice coils with crossover and high-frequency cones and voice coils with crossover at 2,000 Hz. The on-axis frequency response shall be within 8 dB (+4 dB) from 200 to 6,000 Hz. Response 45 degrees off axis shall be within 10 dB of the on-axis response over this frequency range. Power handling capacity shall be 16 watts minimum.

Acceptable: Jensen K-950 or

DuKane 5A 401

Quantity:	Exhibit Hall Lobby	5
	1EL-51EL - Total of 51	6
	Exhibit Hall Public Spaces	8
	1EP - 41EP - Total of 41	9
	Activity Building	11
	1MP-28MP and 30MP-69MP - Total of 68	12
	Theatre Lobby and Public Spaces	14
	1TP-159TP - Total of 159	15
	Total of Three Hundred Nineteen (319)	17

Loudspeaker Matching Transformers for Eight-Inch Loudspeakers 19

Loudspeaker matching transformers shall have an insertion loss not exceeding 1.2 dB throughout the frequency range 200 - 6,000 Hz and shall introduce less than 1% total harmonic distortion at any frequency in this range when drawing 4 watts from the loudspeaker power distribution line. Loudspeaker matching transformers shall be connected for the power consumption from the loudspeaker power distribution line as shown on the drawings. Each loudspeaker matching transformers shall be connected for the power consumption from the loudspeaker power distribution line as shown on the drawings. Each loudspeaker matching transformer shall be firmly affixed to the transformer mounting bracket on the loudspeaker frame.

Acceptable: Altec Lansing 15064 or 33

Jensen 70CV4 or 35

DuKane as provided with eight-inch loudspeakers. 37

Quantity: Three Hundred Nineteen (319) 39

Mounting for Eight-Inch Loudspeakers 41

Eight-inch loudspeakers shall be ceiling-mounted flush with the ceiling plane. Each ceiling-mounted, 8" loudspeaker shall be installed on a flat, perforated metal baffle attached to a conventional "high hat" enclosure. The loudspeaker enclosure shall be filled with a long-fiber glass fiber, 1.5 to 3 lbs./cu. ft. density. The enclosure shall be constructed of No. 22 gauge or heavier steel. Round or square grilles shall be used as directed by the Architect. Finish shall be as directed by the Architect.

Acceptable (round): Lowell CP-87 enclosure with RS -8-A baffle, or 52

Soundolier 95-8 enclosure extended to 7" height 54

with 61-8 baffle, or 56

Acceptable (square):	Soundolier 191-78 enclosure with 164-8 trim square, <u>or</u> Lowell P70X grille	2 5 6
Quantity:	Three Hundred Nineteen (319)	8
<u>Distributed System Horn Loudspeakers:</u>	The loudspeakers shall be of high-efficiency compound horn design and shall be connected for operation at 1 watt by appropriate connections to the integral matching transformer.	10 11 12
	The loudspeakers shall be wall mounted as shown on the drawings.	14
Acceptable Loudspeakers:	Electro-Voice FC100 with driver 1828T. (Transformer included)	16 17
Quantity:	Exhibit Hall Kitchen One (1)	19
	Activity Building Second Floor 29MP One (1)	21
	Total: Two (2)	23
<u>Local Volume Controls:</u>	The volume control shall be stepped, attenuator type.	25 26
Acceptable:	Jensen LT-810 <u>or</u> Clarostat CIB-8	28 30
Quantity:	Four (4)	32
<u>Meeting Room Loudspeakers:</u>		34
Eight Inch Loudspeakers		36
Eight-Inch loudspeakers shall employ separate low-frequency and high-frequency cones and voice coils with crossover at 2,000 Hz. The on-axis frequency response shall be within 8 dB (+4 dB) from 200 to 6,000 Hz. Response 45 degrees off axis shall be within 10 dB of the on-axis response over this frequency range. Power handling capacity shall be 16 watts minimum.		38 39 40 41 42 43
Acceptable:	Jensen K-950 <u>or</u> DuKane 5A 401	45 47
Quantity:	Meeting Rooms 206, 204 and 202 - Forty (40) 1M-40M	49
	Meeting Rooms 208 and 200 - Eleven (11) 1MS-11MS	51
	Meeting Rooms 139, 136 and 134 - Forty-one (41) 1MA-41MA	53
	Meeting Rooms 141 and 140 - Fourteen (14) 1MB-14MB	55
	Total: One Hundred Six (106)	57

Loudspeaker Matching Transformers for Eight-Inch Loudspeakers

Loudspeaker matching transformers shall have an insertion loss not exceeding 1.2 dB throughout the frequency range 200 - 6,000 Hz and shall introduce less than 1% total harmonic distortion at any frequency in this range when drawing 4 watts from the loudspeaker power distribution line. Loudspeaker matching transformers shall be connected for the power consumption from the loudspeaker power distribution line as shown on the drawings. Each loudspeaker matching transformer shall be firmly affixed to the transformer mounting bracket on the loudspeaker frame.

Acceptable: Altec Lansing 15065 or

Jensen 70CV10 or

DuKane as provided with eight-inch loudspeakers

Quantity: One Hundred-Six (106)

Loudspeaker Enclosures for 8" Loudspeakers

The eight-inch loudspeakers in the Meeting Rooms shall be ceiling-mounted in custom-built wooden enclosures as shown on Drawings. The sound-transparent facing in front of the loudspeakers shall not be less than 40% open. If perforated metal is used, the diameter of the perforation shall be not less than 1/8". All interior surfaces shall be covered with a 1" blanket of glass fiber 1-1/2 to 3 lbs./cu. ft. density. A sample enclosure shall be submitted to the Architect for approval before the contractor commences installation.

Acceptable: Custom-built enclosure as per Drawings.

Quantity: One Hundred-Six (106)

Meeting Room Controls:

Remote Level Controls

A remote level control shall be provided and installed in a wall mounted panel within each subdivided space as shown on Drawings. for Meeting Rooms #206, 204, 202, 208, 200, 139, 136, 134, 141 and 140. Panels shall have locking hinged covers to prevent tampering by unauthorized persons. Each item of equipment mounted therein shall be capable of being conveniently removed for maintenance or repair.

Acceptable: Altec Lansing RA8461-01GGD or

Daven BAL-257-G or

Langevin RAT 633/600/600

Quantity: Ten (10)

Meeting Room Local Loudspeaker Switches: Loudspeaker cut-out switches shall be provided for individual ceiling-mounted loudspeakers as shown in the functional diagram. Switches shall be mounted in a wall panel in their respective rooms and shall be arranged to form a map of the loudspeakers served.

Quantity required: Room 206 - Sixteen (16)

Room 204 - Eight (8)

Room 202 - Sixteen (16)

Room 200 - Six (6)

Room 208 - Five (5)

Room 139 - Fourteen (14)

Room 136 - Sixteen (16)

Room 134 - Eleven (11)

Room 141 - Seven (7)

Room 140 - Seven (7)

Total - One Hundred Six (106)

Note: The contractor shall make sure that all cabinets for the loudspeaker switches and volumes controls operate with the same key.

Sound-Effects Loudspeaker Equipment: The movable loudspeaker systems shall be provided for the Theater sound-effects system. These loudspeaker systems shall be furnished complete with flexible cables and plugs.

Loudspeakers: Each loudspeaker shall be a 15" unit. The loudspeaker shall employ a low-frequency cone and voice coil, and one or two separate high-frequency horn loudspeakers mounted on the low-frequency frame. Crossover from the low-frequency unit shall occur no higher than 1550 Hz. Nominal angular coverage shall be at least 90 degrees. Impedance shall be 16 ohms. Sensitivity rating shall be at least 52 dB (E.I.A.). Power handling capability shall be at least 35 watts program material.

Acceptable: Altec Lansing 604E or

Jensen G-610

Quantity: Four (4)

Enclosures: Each loudspeaker shall be mounted in an enclosure constructed of well-braced plywood at least 3/4" thick, with all permanent

joints tightly glued and screwed. Interior volume shall be from 6 to 8 cubic feet. The enclosure shall be sealed, i.e., there shall be no bass reflex port. All interior surfaces shall be lined with 2" blanket of long-fiber glass fiber material of 1-1/2 to 3-1/2 pounds-per-cubic-foot density, such as Owens-Corning "Aerocor," Gustin-Bacon "Ultralite" or Johns-Manville "Microlite." A protective grille of perforated or expanded metal at least 30% open, with hole diameters at least twice the metal thickness, or of a strong open-weave monofilament plastic fabric, shall be installed over the loudspeaker opening.

Quantity: Four (4)

Transformers for Effects Loudspeakers: Each effects loudspeaker matching transformer shall have an insertion loss not exceeding 0.6 dB throughout the frequency range 50 - 10,000 Hz and shall introduce less than 2% total harmonic distortion at any frequency in this range when drawing 30 or 32 watts from the 70-volt line. The transformers shall be mounted in the enclosures and shall be connected for 30 or 32 watts.

Acceptable: Altec Lansing 15066 or

Jensen ZC-100

Quantity: Four (4)

Finish: Each sound effects loudspeaker system shall be painted flat black. Grilles should be painted with an almost-dry brush, so that holes do not become filled with paint.

Hardware: Each sound effects loudspeaker system shall be supplied with casters, handles, 30' flexible cable and plug. The cable shall be firmly attached to the enclosure and shall be Belden #8472.

Acceptable: Plug, Hubbell 3331

Quantity: Four (4)

Sound Effects Loudspeaker Receptacles: Female-insert loudspeaker receptacles shall be located as shown on the drawings.

Wall-mounted receptacles shall be located 3' above the floor or as directed by the Architect.

Acceptable: Hubbell 3330

Quantity: Fourteen (14)

Monitor Loudspeakers:

Eight-Inch Loudspeaker

The eight-inch loudspeaker shall employ separate low-frequency and high-frequency cones and voice coils with crossover at 2,000 Hz. The on-axis

frequency response shall be within 8 dB (plus or minus 4 dB) from 200 to 6,000 Hz. Response 45 degrees off axis shall be within 10 dB of the on-axis response over this frequency range. Power Handling capacity shall be 16 watts minimum.

Acceptable: Jensen K-950 or

DuKane 5A 401

Quantity: Theater Sound Control Room Two (2)

Theater Projection Room One (1)

Theater Light Control Room One (1)

Theater Follow Spot Booths Two (2)

Theater Control Room
(for sound effects) Two (2)

Exhibit Hall Control Room Two (2)

Activity Building Second
Floor Sound Control Room One (1)

Activity Building First Floor
Sound Control Room One (1)

Total of Twelve (12)

Enclosures for Monitor Loudspeakers: The eight-inch monitor loudspeakers shall be wall surface-mounted in wooden enclosures having a minimum enclosed volume of 3/4 cu. ft., with the grille facing the control position. The enclosures shall have a sound-transparent facing in front of the loudspeakers, and all interior surfaces shall be covered with a 1" blanket of glass fiber 1-1/2 to 3 lbs./cu. ft. density. Finish and grille as specified by the Architect.

Monitor Loudspeaker Matching Transformers: Each transformer shall have an insertion loss not exceeding 1.2 dB throughout the frequency range 100 - 10,000 Hz and shall introduce less than 2% total harmonic distortion at any frequency in this range when drawing 4 watts from the 70-volt line. Each transformer shall be connected for 2 watts as shown on Drawings N-4, N-5 and N-6.

Acceptable: Altec Lansing 15074 or

Jensen 70CV4

RCA MI-12368

Quantity: Twelve (12)

Volume Controls for Monitor Loudspeakers: The controls shall be wall-mounted in a convenient position for control for the light control and projection rooms. In sound control rooms the controls shall be rack mounted.

Acceptable: Jensen LT-810 or

Clarostat CIB-8

Quantity: Twelve (12).

Loudspeaker Distribution and Switching Lines: Loudspeaker distribution and switching lines shall be stranded, twisted pair, color-coded to facilitate proper connection and phasing in the following AWG gauges:

Theater Central System #12AWG

Exhibit Hall System - #14AWG

Exhibit Hall Lobby - #16AWG

Meeting Room System - #16AWG

Loudspeaker Phasing: All loudspeakers in each system shall be properly phased with respect to each other.

Miscellaneous Equipment:

Switching Equipment: Switching facilities required are indicated on the functional diagrams. These diagrams do not necessarily indicate all switches included in these systems. All switches used in these systems, whether or not mentioned or shown in this specification, shall have clearly marked titles and positions, and shall have sufficient voltage and amperage rating to cover the use for which they are required with a safety factor of at least 2. All toggle switches handling audio circuits shall meet JAN-S-23 or MIL-S-3950A specifications. All rotary switches handling audio circuits shall be instrument switches as manufactured by Langevin or Daven. Only switches in manufactured equipment specified herein by model number shall be exempted from these requirements.

Audio Transformers: All audio transformers used in these systems shall be of appropriate impedance ratio and power handling capacity for the function intended and, unless otherwise specified herein, shall have a frequency response of within \pm dB from 20 to 20,000 Hz.

Earphones: High-impedance earphones shall be provided to permit cueing of recorded materials, and to permit signal tracing through the system. The earphones shall be supplied complete with headband, cord, and plug to fit the system patch panels.

Acceptable: Sony DR-3C

(connected in parallel) with new plug to fit panel jacks

Quantity: Theater - One (1)	5
Exhibit Hall - One (1)	7
Meeting Rooms - One (1)	9
Total of Three (3)	11

INSTALLATION

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Take such precautions as are necessary to prevent and guard against
electromagnetic and electrostatic hum, to supply adequate ventilation
and to install the equipment so as to provide safety for the operator.

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Care shall be exercised in wiring, so as to avoid damage to the cables
and to the equipment. All joints and connections shall be made with
rosin-core solder or with mechanical connectors approved by the Acoustical
Consultant. All wiring shall be executed in strict adherence to standard
broadcast practices.

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Lines shall be run in separate conduits for microphone-level circuits
(levels below -20 dbm), line-level circuits (up to +30 dbm), loudspeaker
circuits (above +30 dbm), and power circuits. Telephone lines used for
broadcast shall be run separately. All other conduit shall be well
spaced from power conduits. Power conduits shall be grounded with heavy
shielded wire to the power system ground. Microphone and 600-ohm lines
shall be insulated from the conduit and from each other for the entire
conduit length. Microphone and 600-ohm line conduits shall be
mechanically and electrically connected to receptacle boxes, and electrically
grounded to a copper stake or similar earth connection. Lines in conduit
shall not be spliced.

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Microphone line shields shall be grounded only at the microphone frame
and to the control console input connectors. Other shields shall be
grounded only at the power amplifier inputs or the console outputs, and
shall be terminated at the "floating" end with "wedge-on" collars, or
with plastic tape. Continuity of shields shall be preserved at connec-
ting points. All audio grounds in the equipment racks shall be
connected to a common point on the rack; the racks shall be grounded to
a copper stake, or similar earth connection. All racks in the same room
shall be grounded to a single point.

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All material finishes and colors and the final appearance of all equipment
shall be subject to the review of the Architect.

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SUBMITTALS

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Shop Drawings: Prepare 6 copies block diagrams indicating the proposed
connections of all equipment to be furnished, drawings of loudspeaker
mounting arrangements, control facilities, and equipment racks. These
drawings must be reviewed by the Architect before the contractor commences
fabrication or installation.

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As-Built Drawings: Prepare as-built drawings of completed systems in the
manner prescribed in Division 1.

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