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ABSTRACT

Intended to serve as a means of communication between school agencies and the design professions, this guide provides a checklist for the development and review of mechanical and electrical plans and specifications by engineers, architects, and superintendents in planning public school facilities. It is also intended to facilitate the approval of plans and the inspection of projects by the various agencies of State government. Specifications mandatory by law, code, or regulation, and those specifications simply recommended (with deviation requiring clearance) are indicated. (Author/MLF)

SCHOOL PLANNING GUIDE SERIES - 4

NORTH CAROLINA DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF SCHOOL PLANNING, RALEIGH AUGUST 1969

MINIMUM CHECK LIST FOR MECHANICAL AND ELECTRICAL PLANS AND SPECIFICATIONS

MINIMUM CHECK LIST

FOR MECHANICAL AND ELECTRICAL PLANS AND SPECIFICATIONS

DIVISION OF SCHOOL PLANNING • N. C. DEPT. OF PUBLIC INSTRUCTION • 1969

CONTENTS

ABBREVIATIONS

AGA	AMERICAN GAS ASSOCIATION
IBR	INSTITUTE OF BOILER AND RADIATOR MANUFACTURERS
IES	ILLUMINATING ENGINEERING SOCIETY
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NEC	NATIONAL ELECTRICAL CODE—1968
NFC	NATIONAL FIRE CODE—1968-69
NSF	NATIONAL SANITATION FOUNDATION
NCBRR	NORTH CAROLINA BOILER RULES AND REGULATIONS—1969
NCGS	NORTH CAROLINA GENERAL STATUTES (AS AMENDED TO 1967)
NCSBC	NORTH CAROLINA STATE BUILDING CODE—1967
SBI	STEEL BOILER INSTITUTE
UL	UNDERWRITERS' LABORATORIES, INC.

• This mark represents those items that are new or have been revised

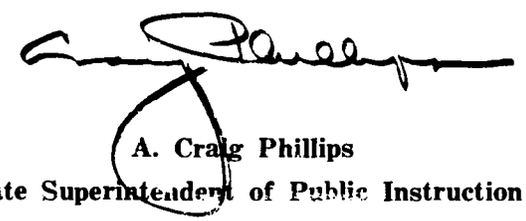
FOREWORD

Students, teachers, educators, architects and engineers are very much aware of the importance of the physical environment to the education process. In recent years progress has been made toward improving the environment, and this improvement has been the result of considerable effort on the part of educators and those engineers and architects involved in the design of public school facilities. Along with this has been the companion effort to improve the design and installation of the total mechanical and electrical systems, all to the best interests of the student and the school system. This, too, has been a joint effort by all parties involved. For the most part, the results have been very gratifying.

Some ten years ago the professional staff of the Division of School Planning recognized the need for a suitable publication to serve as a means of communication between school agencies and the design professions. Hence the "Redbook" was first developed in 1960. It is and should remain a "minimum" check list that includes concise, pertinent and well-chosen comments without being voluminous. It should be noted that the publication represents the thinking of a good cross section of the design professions.

As a Department of Public Instruction publication, it is hoped that this Minimum Check List will continue to serve a useful purpose in the engineering and architectural design process as applied to public schools.

August, 1969



A. Craig Phillips
State Superintendent of Public Instruction

PREFACE

This publication has been prepared for use as a Minimum Check List in the development and review of mechanical and electrical plans and specifications by engineers, architects and superintendents in planning public school facilities. Need for such a publication was indicated by engineers who design these facilities. Furthermore, it was felt that a check list would facilitate approval of plans and inspection of projects by the various agencies of State government.

The first edition of this Minimum Check List was developed in 1960 by the engineering staff of the Division of School Planning. Revisions were made in 1962 and 1965. Assistance in editing and revising this publication from its beginning has been given by representatives of the Divisions of Insurance and Plant Operations, State Board of Education, the Department of Insurance, the Department of Labor, the State Board of Health, the Professional Engineers of North Carolina and the North Carolina Chapter of the American Institute of Architects. Representatives of all these groups have assisted in reviewing this revised edition.

Appreciation is expressed to all these individuals and especially to the following committee:

John Andrews, Board of Health
R. B. Boyd, Department of Insurance
H. L. Buffaloe, Professional Engineers of N. C.
M. E. Burrows, Professional Engineers of N. C.
E. L. Clodfelter, Department of Labor
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G. B. Rottman, Professional Engineers of N. C.
J. F. Stamey, Board of Health
L. S. Thompson, Division of School Planning
Marvin Ward, Winston-Salem/Forsyth Schools
Harvey Winslow, Department of Insurance

In using this check list, the following interpretations should be kept in mind:

- Items using the term "shall" are mandatory because of law, code or regulation.
- Items using the term "should" are those which experience has taught are most practical and desirable. Any deviation should be supported by adequate information and reasoning, and should be cleared with the Division of School Planning in the early stages of the design process.
- Other items are included as good practices about which professional people may not entirely agree.

This publication is another effort to improve communications among all who are interested in and concerned with the planning and construction of school facilities. It is our hope that this bulletin will be of value to all of us in our efforts to provide the best possible facilities for the school children of North Carolina.

J. L. Pierce, Director
Division of School Planning
Department of Public Instruction

August, 1969

P-100.00 Drainage, Wastes and Vents

101.00 Floor drains are needed in all toilet rooms containing more than one water closet, and at all points where water heaters are located.

● 101.01 Infrequently used floor drains should have traps resealed by waste from clear water fixtures.

● 101.02 Provisions should be made for resealing traps of floor drains located in rooms being used as return air plenums. It is recommended that these drains be 4" minimum size, and that sediment strainers be used.

● 101.03 Drains in toilet areas should be not less than 3" size.

102.00 Floor drains shall not be installed in food storage areas.

● 103.00 Floor drains shall be provided for boiler rooms, and for mechanical equipment rooms containing any equipment using steam or water, or incorporating cooling coils.

104.00 The plumbing plans must bear the seal of the engineer who is responsible for the design, and is by law obligated to inspect and issue a "Certificate of Compliance" upon completion of the project (NCGS 133-1.1).

105.00 Acid-resisting waste lines should be considered for chemistry laboratories in senior high schools, and perhaps some other special uses such as the chemistry instructor's table in a junior high school. They are not considered necessary for any other normal laboratory areas.

105.01 Corrosion-resistant traps are required on all fixtures in chemistry classrooms, and may be used if desired in other laboratories such as physics and biology.

● 105.011 P-traps to the wall, or located below floor are preferred to S-traps to floor.

105.02 Plaster and/or interceptor traps are usually needed for work sinks in areas such as art classrooms.

● 106.00 It is recommended that vent pipe flashings be made in two pieces. One of these should be a cap which slides down over top of the pipe, and sufficiently overlaps the base flashing.

● 106.01 Screens, to protect against gravel, rocks and etc., are recommended for installation on these flashings

● 107.00 Cleanouts placed in horizontal pipe runs should be fabricated using longsweep one-quarter bends or fittings providing one-eighth turn. Standard one-quarter bends should never be used.

● 107.01 In clay (V.C.) pipe sewer lines, cast iron fittings should be provided at the base of cleanouts to prevent breaking with end of the sewer rod.

● 108.00 Roof drainage shall be designed in accordance with requirements of the NCSBC, Plumbing, Chapter XV (as a minimum). Provisions for wind effect should be incorporated in the design, ie, consider the wind blowing all rain to one side of the roof.

● 108.01 The actual installation of roof drains and flashings, for interior roof drain systems, should be made by the general contractor. Piping for such systems should be by the plumbing contractor.

P-200.00 Fittings

201.00 All hose bibbs should have minimum 18" clearance underneath.

● 202.00 A hose bibb with a removable handle or a key operated lock shield should be installed in any toilet room having a floor drain.

203.00 Each fixture should have an individual water supply cutoff valve.

204.00 Flush valves must be equipped with vacuum breakers (NCSBC, Plumbing, Section 1205.1).

● 205.00 Use freeze-proof hose bibbs where applicable; these should be key operated.

P-300.00 Fixtures

● 301.00 Lavatories should be acid-resisting, and have rigid supplies. Also, strainers (beehive type are suggested) and not pop-up or plug should be used in lavatory wastes in public toilets or rest rooms.

302.00 Elongated bowls and open-front seats for water closets are required by Code (NCSBC, Plumbing, Sections 907.1 and 907.6).

● 303.00 A lavatory shall be located in the kitchen area for handwashing.

● 303.01 This lavatory shall have a mixing faucet supply fitting.

304.00 A service sink or a receptor should be located within the confines of the kitchen area.

● 304.01 If supply fitting for this fixture has hose-thread nozzle a backflow preventer shall be specified (NCSBC, Plumbing, Section 1205.5).

● 305.00 All hose bibbs must be equipped with backflow preventer (NCSBC, Plumbing, Section 1205.5).

306.00 Standard, single purpose fixtures should be used where waterworks and plumbing are concerned; i.e., a handwashing lavatory should not be combined with a drinking fountain; a mop sink should not be combined with a handwashing lavatory, nor should one be substituted for the other.

307.00 Drinking fountains outside a building shall be frostproof. All wastes from these should be carried to dry wells or storm drains.

308.00 Counter top sinks should have ledges with holes to receive faucets. Faucets should not be mounted in counter tops.

309.00 Supplies (pipe, valves and fittings) that are concealed, such as for counter top sinks, do not need to be the rigid type, and need not be plated.

310.00 Gymnasium dressing rooms should have drinking fountains. These should not be water coolers.

311.00 Wall-hung type urinals are recommended.

● 312.00 Carrier-mounted fixtures, where possible, are recommended.

P-400.00 Water Supply (See Sections 7 and 8 of the NCBRR and Chapter XII of the NCSBC, Plumbing)

401.00 Wells must be located away from possible sources of contamination, properly protected, and well sites must be approved by a representative of the State Board of Health.

402.00 At school sites where well water systems are planned, owners, architects and engineers are urged and encouraged to consult the State Department of Water and Air Resources for geological information.

403.00 Plans shall show the location of the well, and complete details of the well supply system including well, pump, pump house, piping and storage tank.

403.01 When an elevated tank is installed, it is strongly recommended that a fire hydrant be properly located on the site.

404.00 When water is obtained from a public system, plans shall show location of the water supply connection, and size of the water meter.

404.01 Pressure reducing stations should be utilized where supply pressure exceeds 75 psig.

405.00 Dishwashing and showering are the two factors to consider in sizing water heating equipment. Such equipment should be placed where components can be easily maintained.

405.01 180-degree water heaters should carry the NSF label, or equal (NSF Standard No. 5).

405.02 Sanitizing hot water from water heater to dishwasher booster heater should be recirculated by pumping in order to maintain maximum temperature at the booster.

406.00 Water heaters and/or storage tanks must have safety valves that are sized and installed in accordance with requirements of the NCBRR.

406.01 Water heaters incorporating the use of dip tubes must conform to the requirements of the NCBRR.

407.00 All hot water storage equipment should have tanks equipped to prevent interior corrosion.

408.00 For electric water heaters of all types, the designer must be careful to comply (1) with all the requirements of Article 422-14 in the NEC; and (2) NCBRR requirements for the UL label. Control voltage should be 120-volts only.

409.00 State Department of Labor operating certificate shall be mounted under glass and placed near the heater (NCBRR, Section 7, Rule 8 and Section 8, Rule 14).

410.00 Circulators for domestic hot water use should be all-bronze construction.

411.00 All water supply systems should be disinfected before being placed in service.

P-500.00 Sewage Disposal Systems

501.00 Locations and principal elevations of connections to public sewer systems shall be shown on plans (NCGS 130-13).

502.00 When an on-site sewage disposal system is planned, the site and the proposed system must be approved by the State

Board of Health. Plans and specifications must be submitted to that agency. Board of Health approval must be made before the Department of Public Instruction can issue its Certificate of Approval.

● 503.00 Plans for sewage disposal systems shall include complete details and elevations of all units and appurtenances, including profile from buildings to final point of waste disposition.

● 504.00 There should be a complete summary of plumbing loads, in fixture units, shown on the plans.

● 505.00 For aeration type sewage plants (on-site): (1) a suitable fence (which should include barb wire at the top) is mandatory to exclude children from this dangerous area, and (2) the manufacturer's standard covering for the entire tank is recommended.

P-600.00 Gas Systems

601.00 All gas systems, whether for LP or natural gas, must conform strictly to the requirements of the NFC, Section 54, Volume 2 entitled "Gases".

● 602.00 In particular, the two areas in Section 54 that are of most concern are (1) the kinds and types of pipe that are acceptable for gas; and (2) the allowable methods for installing pipe with respect to routing, placement, special treatments and valving arrangements.

603.00 The Division of School Planning recommends that pipe, and not tubing, always be used for gas systems.

604.00 It is recommended and requested that all gas piping be specified to have a 100 psi air test with soap solution applied to all joints.

P-700.00 Grease Traps

● 701.00 Exterior grease traps should be installed when recommended by the State Board of Health, or when required by local regulation. Applicable directions and instructions should be closely followed.

702.00 Interior grease traps are not recommended.

CHART—PLUMBING FIXTURE RECOMMENDATIONS

FIXTURE AND APPLICATION	MOUNTING HEIGHTS	FIXTURE-STUDENT RATIOS
WATER CLOSETS		
Grades Kindergarten through Three, Boys	13″	1 to 40
Grades Kindergarten through Three, Girls	13″	1 to 30
Grades Four through Six, Boys	15″	1 to 40
Grades Four through Six, Girls	15″	1 to 30
Junior and Senior High Boys, Seven through Twelve	15″	1 to 50
Junior and Senior High Girls, Seven through Twelve	15″	1 to 40
URINALS		
Grades Kindergarten through Three	18″	1 to 30
Grades Four through Six	20″	1 to 30
Junior High, Seven through Nine	22″	1 to 30
Senior High, Ten through Twelve	24″	1 to 30
LAVATORIES		
Grades Kindergarten and One	24″	1 to 35
Grades Two through Six	27″	1 to 35
Junior and Senior High, Seven through Twelve	31″	1 to 40
DRINKING FOUNTAINS		
Grades Kindergarten through Three	24″	1 to 50
Grades Four through Six	28″	1 to 50
Junior and Senior High, Seven through Twelve	34″	1 to 75
SHOWERS (SEE NOTES BELOW)		
Elementary Boys and Girls	50″	
● Junior High Boys, Seven through Nine	66″	1 to 4
● Junior High Girls, Seven through Nine	56″	1 to 4
● Senior High Boys, Ten through Twelve	70″-72″	1 to 4
● Senior High Girls, Ten through Twelve	58″	1 to 4

● Notes: (1) Ratios are for physical education installations.
(2) Shower mounting heights should be measured from the finished floor to the center line of the shower head.

M-100.00 General

101.00 The State Department of Labor boiler and tank operating certificate shall be mounted under glass in the boiler room (NCGS 95-65, 95-65.1).

102.00 Adequate free combustion air shall be provided in the boiler room (NCBRR, Section 10. Rule 17(b)).

● 103.00 Motor overload protection must be as specified by the NEC. For three-phase motors, protection is necessary for all three phases (NEC 430-37).

● 104.00 Gutters are prohibited on range hoods. The range hood should be mounted so that there is a minimum of 6'-6" and a maximum of 7'-0" clearance from the floor, and it should be constructed so that there is at least 12 inches vertical rise before the hood starts to taper. Rang hoods should cover the entire area of the cooking equipment, and surround such area by at least six inches.

● 104.01 Capacity of the range hood fan should be 100 cfm (maximum) per square foot of hood area.

● 104.02 It is recommended that ventilation air be discharged straight up all the way.

● 105.00 Adequate quantities of filtered make-up air should be provided for all exhaust fans.

106.00 Engineers should size all valves on the plans.

107.00 There should be a complete heating summary shown on the plans, either all or in part as is appropriate for a given school, as follows:

107.01 The new load.

107.02 The existing load; where this information is not available, the owner should make arrangements to provide it either by the design consultant or some other means.

107.03 The capacity provided for known future expansion.

107.04 The spare capacity provided if this is different from Item 107.03.

● 107.05 The domestic hot water load where applicable.

107.06 The net SBI or IBR capacity of the boiler or boilers.

108.00 Heating design conditions shall be stated on the plans.

109.00 The mechanical plans must bear the seal of the engineer who is responsible for the design, and is by law required to inspect and issue a Certificate of Compliance upon completion of the project (NCGS 133-1.1).

● 110.00 Boiler room floors should be at or above grade elevation unless there is some important reason for going below grade.

● 111.00 The engineer should select all "running" equipment with respect to the noise factor, especially that which is to be used in occupied spaces.

MECH 10

M-200.00 Stack and breeching

201.00 Stack

201.01 There should be a hinged cleanout door for the chimney.

● 201.02 A flue lining is required (NCSBC, Section 1002). Coordinate with the architect.

● 201.03 A precast flue thimble or fire brick lining is needed where the breeching enters the chimney. Coordinate with the architect.

201.04 Connections at the thimble, breeching and chimney must be airtight for efficient operation.

201.05 For coal fuel and on new work, the use of induced draft fans is discouraged. In all cases, chimneys should be of sufficient heights to effect proper smoke abatement.

201.06 An induced draft fan should be supported independently of the breeching, have an expansion joint and should not obstruct normal access to the boiler.

202.00 Breeching

202.01 The breeching should be supported independently of the boiler.

202.02 Enough cleanouts, properly located, should be provided to promote easy, periodic cleaning.

202.03 A barometric damper should be used where applicable.

202.04 In multiple boiler installations, a locking-type damper should be installed in each separate boiler breeching.

M-300.00 Boilers

301.00 There shall be at least three feet clearance on top of the boiler (NCBRR, Section 9, Rule 17). Three feet clearance is also recommended on the sides.

301.01 Low pressure boilers with manholes should have at least four feet ceiling clearance.

301.02 The ceiling clearance changes to five feet for high pressure boilers.

302.00 The safety and/or relief valve capacity must be specified (NCBRR, Sections 5 and 6, Rules 8 and 9).

303.00 For tube removal and cleaning, steel boilers shall have a minimum clearance of the length of the longest tube, plus 12 inches, at the front.

● 303.01 Cast iron boilers should have sufficient clearance for cleaning and firing. This is normally the length of the boiler plus 12 inches.

304.00 When sections are added to a cast iron boiler, the name plate and safety valve must be changed to comply with the new rating (NCBRR, Section 6, Rules 8(g) and 9(d)).

305.00 Boiler ratings

● 305.01 The SBI net rating should be shown for a steel boiler. Boiler selection should be made with respect to load, piping and pick-up.

305.02 The IBR net rating for a cast iron boiler should be specified.

305.03 Where catalogues show only gross boiler ratings, care should be taken to determine the true net ratings, and proper selection should be made with respect to both the direct connected load and necessary pickup and piping losses (as applicable to schools).

306.00 For stokers, the following firing tools are needed: (1) flue brush, (2) clinker tongs, (3) hook bar and (4) hoe.

307.00 Safety valve and relief valve discharge lines should be run to within 6" of the floor, and near a floor drain (NCBRR, Section 6, Rule 12).

308.00 The discharge line from the safety and/or relief valve shall be supported other than by the valve itself (NCBRR, Section 6, Rule 12).

309.00 Use copper wire to secure the insulation to the boiler unless insulation studs are used.

310.00 Do not cover manholes, handholes, rodholes, name plate or ASME stamping on the boiler.

● 311.00 If the boiler has a hot water heating coil in it, the coil shall be connected in such a manner that the coil cannot be subjected to pressures above those for which it was designed. A pressure relief valve is necessary for this coil.

312.00 The boiler bottom blowdown valve or valves, and piping, must be sized and arranged in accordance with requirements of the NCBRR, Section 6, Rule 17.

313.00 The return connection at the rear of the boiler should be connected to either the center tap or to the center of a header connecting the two outside taps in order to provide even return flow into the boiler.

314.00 Boiler piping, as installed, should not restrict the use of the smoke hood cleanout door, manhole openings and plugged openings.

315.00 A minimum of one brick course or a 3" thick concrete base should be installed under a boiler and its firing device to prevent corrosion.

316.00 Brick and refractory settings for boilers usually should be done by qualified refractory contractors.

317.00 Cross-type fittings should be used on steam boiler piping at water columns, water feeders and LW cutoffs for cleaning purposes.

● 318.00 When specifying steam boilers, engineers should be very careful to properly evaluate the steam and water capacities (volumes) of the boilers in relation to the system served, and in relation to the kind of firing to be applied (gas, for example). Too little capacity results in some severe problems such as difficulty with holding the water line. The method of feedwater control becomes very important, and this should be properly designed and shown in detail on the plans. Each steam boiler application should be fully engineered to suit the system it will serve.

M-400.00 Stokers

401.00 The stoker size shall be based on the use of N. C. specification coal, weighting 44 pounds per cubic foot and having a heating value of 13,500 B. T. U. per pound, for the gross capacity of the boiler (not the connected load).

402.00 The stoker installation should comply with the manufacturer's specifications.

403.00 Rear and side feed stokers are highly recommended.

404.00 If the stoker must be the front feed type, it should be sufficiently longer than standard length to provide proper clearance for firing and boiler maintenance. This proper clearance would be in the order of six feet, sometimes less than this.

405.00 A clinker tray is necessary with a front feed stoker, and is recommended in all cases.

406.00 Metal windbox type stokers with castable hearth settings shall be used.

407.00 Provision shall be made to remove the stoker coal feed screw and motor.

408.00 Stokers or boilers shall not be placed in pits.

409.00 The stoker wind tube and coal feed tube should have masonry supports on long runs.

410.00 Stoker controls should be mounted on a panel having an air space behind it.

411.00 A good set of stoker controls should contain at least the following:

411.01 Hold-fire relay

411.02 Water temperature or steam pressure operating control and high limit control (NCBRR, Section 6, Rule 16).

411.03 Magnetic starter (if necessary)

411.04 Snap switch

411.05 Low water cutoff

411.06 Disconnect switch with time delay fuses

411.07 Seven-day time clock with bypass switch

412.00 Refer to the typical stoker control diagrams that follow in this section.

M-500.00 Oil Burners and Oil Storage Tanks

501.00 Light fuel oils, unheated, are definitely recommended as fuels rather than heavy oils.

502.00 Oil burner controls:

502.01 A "stackswitch" type primary control is satisfactory for approximately 3 gph and lower firing rates.

● 502.02 An electronic, program type primary control should be used for a firing rate greater than 3 gph. In addition to safety cutout, this would provide prepurge and postpurge of the boiler.

503.00 The combustion chamber design should be exactly specified and detailed on the drawing. The desired materials should be set forth, and the design should be in strict accordance with manufacturer's recommendations.

● 504.00 Oil storage tank capacity should be relative to the size of the heating plant, and to local service and delivery conditions. Normally a 10,000-gallon tank, minimum capacity, is required to obtain lowest cost through central purchasing.

● 505.00 The tank should be thoroughly coated externally with a suitable protective compound, in the field, just prior to installation. A good treatment would be one coat of red lead paint and two coats of black asphalt.

506.00 Tank should be fabricated of heavy gauge metal, and should bear the Underwriters' Label.

507.00 Tank shall be installed in strict accordance with all governing fire and building codes.

● 507.01 All tanks should be installed underground.

● 507.02 Fill end of tank should be 4″ to 6″ low.

508.00 Tank should be adequately anchored.

M-600.00 Steam, Hot Water and Cooling Piping

601.00 Pipe tunnels are recommended, and should be large enough to work in. This recommendation applies to those cases where pipe must be placed below grade or below floor slab. (Please see next item).

● 602.00 Heating system pipe should never be placed underground or below slab on grade unless there is no other possible choice. Condensate lines, which must necessarily be placed underground at times, should be either wrought iron or copper, Type "K". All wrought iron pipe underground should be welded. Fittings for copper pipe should be wrought type, and joints should be made with 95-5 solder or better.

603.00 When it is necessary to install condensate pipe underground (that is, under a slab on grade), the practice of placing the pipe, wherever possible, outside the periphery of the building is highly preferable to placing it under the slab.

604.00 Insulation in the boiler room should have a canvas jacket applied, minimum 8-ounce weight.

● 605.00 Pipe anchoring and provisions for expansion (by means of expansion fittings, swing joints or expansion loops) must be provided where necessary.

606.00 Install unions in all pipe lines for the removal of traps, valves, strainers, etc., except when the fitting is the combination union or flange type.

607.00 A piping hook-up detail for each piece of heating and cooling apparatus, including boilers, pumps, hot water gen-

erators and tanks, converters, radiation units, forced air heating and cooling units and drip assemblies, and for all points where special piping conditions exist, should be shown on the plans.

608.00 Pitch directions for all heating and cooling (water) lines should be shown on the plans.

609.00 The locations of piping runs (such as above ceilings, exposed at ceilings, etc.) should be indicated by notes on plan drawings.

M-700.00 Radiation

701.00 Individual control valves should be sized large enough not to restrict capacities.

702.00 Strap-on limit controls, to prevent cold operation, should be installed on all unit heaters and cabinet heaters that are not used also for ventilation or cooling. Unit heaters in shops, for example, that are desired for circulating air separately from heating may include an additional on-off-automatic control to accomplish this.

703.00 Valves, balancing cocks and traps should be accessible (not behind covers without access panels).

704.00 The fronts and ends of radiation covers should have a minimum thickness of 16 gauge.

M-800.00 Controls

801.00 Engineers should specify in detail all controls, and describe sequences of operation.

802.00 All controls, starters, switches, etc., should be permanently labeled after installation.

803.00 Heating control diagrams should appear on the plans.

804.00 Rigid guards, of cast iron, or similar construction, are needed to cover thermostats in gymnasiums, dressing rooms and shops.

805.00 An override control for a stoker-fired boiler is necessary, and should be shown in the stoker control diagram.

806.00 When an induced draft fan is used, a prepurge and low draft switch should be installed. Post-purge should not be used on stoker installations. Manufacturer's recommended pipe size from the breeching to the controller must be followed.

● 807.00 Any control circuit for any kind of space heating device or water heater should be a phase-to-ground circuit. A phase-to-phase circuit should not be used. The only voltages recommended are 120-volts and 24-volts.

M-900.00 Hot Water Heating Systems

● 901.00 Feed or make-up water to the boiler should be fed at the return connection to the boiler and shall be piped to comply with NCBRR, Section 6, Rule 21.

902.00 There should be a valved bypass around the pressure regulating valve serving the system.

903.00 The low water cutoff should be installed normally in the riser line off the boiler nozzle (NCBRR, Page 66, and the diagram entitled "Hot Water Boilers in Battery" that follows herein).

904.00 A balancing line is good practice if more than one compression tank is used (NCBRR, Section 6, rule 24).

● 905.00 Air control fittings at boilers and compression tanks are necessary. On large installations the use of separate chamber air elimination devices is recommended.

905.01 A shut-off valve should be installed in the pipe line to each expansion tank for servicing.

906.00 Hot water circulating pumps should have bronze impellers.

907.00 When two hot water boilers are used together and are stoker fired, the stokers should be operated by one temperature control device located in a common header. This does not alleviate the necessity for having an individual high limit control for each stoker (refer to the diagram that follows in this section).

908.00 Reverse return design of hot water heating system piping is highly desirable, and should be used.

909.00 Automatic valves should be the same size as the pipes except where modulating valves are used.

910.00 In multiple boiler installations, piping arrangement at boilers and pumps should be such that water flow is equally divided through each boiler. With respect to balanced flow and direction of flow, attention is called to the diagram that follows in this section as a recommended arrangement. In general, pumping away from the boiler (s) to the system is by far the most workable method.

911.00 All compression tanks should be specified to meet ASME Code construction, and be so stamped.

912.00 Manual type air vents should always be used instead of the automatic type.

913.00 For economical reasons, the installation of standby pumps is not recommended. When warranted, a spare motor could be supplied.

914.00 Pumps shall have a cutoff valve on each side for servicing. One valve may be an air-tested balancing cock.

915.00 A simple flow diagram is usually a big help in defining the system.

● 916.00 Boilers must never be piped for reverse flow.

M-1000.00 Steam Heating Systems

● 1001.00 The low water cut-off and safety water feeder should be set at a level 2½" below the normal water level of the boiler (NCBRR, Section 6, Rule 18).

1002.00 The condensate pump should be sized for the net capacity of the boiler.

1003.00 The condensate pump should have a cast iron receiver.

1003.01 Vertical, underground type pumps are preferred over floor-mounted types installed in pits.

1004.00 When two steam boilers are used together and are stoker fired, the stokers should be operated by one pressure control device located in a common header. This does not alleviate the necessity for having an individual high limit control for each stoker (refer to the diagram that follows in this section).

● M-1100.00 Gas Heating Systems, Gas Burners and Gas-Fired Boilers

● 1101.00 Gas heating systems, direct-fired, must be installed in accordance with provisions of the NCSBC, Section 2902. Any other type of direct-fired system is not permissible.

● 1102.00 When a direct-fired, gas system is to be used for a public school building, it is urgently recommended and requested that the designing engineer and architect hold a meeting in the preliminary stages with the Division of School Planning and the Department of Insurance, if necessary, to discuss the matter in detail. This would be highly beneficial to all parties concerned with respect to system and equipment selections, and in avoiding design considerations prohibited by code and/or law.

● 1103.00 Gas burners, for boiler firing, are recommended to be of the atmospheric (non-pressure) type in the lower range of sizes (up to approximately 2,000,000 btu input). Factory engineered units, incorporating boiler and burner, are preferred over other types.

● 1104.00 Use and proper application of the best grades of gas combustion equipment and safety controls are mandatory. All equipment and controls should be specified to be in strict accordance with manufacturers' recommendations and the best accepted practices, and they must meet requirements of the AGA. The engineer is reminded here that control equipment set forth in printed material by manufacturers, although it is probably adequate from a safety standpoint, is usually minimum. Hence, combustion control components should be carefully engineered to produce the degree of safety and performance needed in public school applications. Attention is called to the requirements of NCBRR, Section 6, Rule 24. Please refer to the diagrams that follow herein.

● 1105.00 The approved methods of installing gas piping, and the types of pipe and fittings to be used are of considerable importance. Specifications and/or plans should state these items in detail. The requirements of NFPA 54 are mandatory, and hence should be adequately shown and described.

1106.00 Gas piping test should be the same as that referred to in Item P-604.00.

● 1107.00 Reference is made to the installation of direct gas-fired heating equipment (with or without cooling) on roof tops. This Division recommends and requests that both engineers and architects carefully evaluate such equipment to determine if it is actually fabricated for long life expectancy when mounted outdoors. This Division further recommends that serious consideration be given to adequately sheltering or fully enclosing such roof-top equipment in all cases.

● 1108.00 Pipe lines venting gas from appliances or devices must terminate outside the building.

● M-1200.00 Electric Heating Systems

● 1201.00 Each proposed electric heating application should be evaluated with respect to the energy unit cost (per kw-hour).

That is, the engineer should assure that the owner will receive an energy cost rate at or very near the all-electric rates for public schools as set forth by the major power companies. This is a vital factor in determining whether to select an electric heating system.

● 1202.00 All items of electric equipment installed in North Carolina public schools must bear the Underwriters Laboratory Label as required by NCGS.

● 1203.00 Safety, and all the requirements of the NEC are mandatory in electric system design. Specifically, attention is directed to the 1968 National Electric Code, Article 424-Fixed Electric Space Heating Equipment. It should be noticed that this is a new article.

● 1204.00 When large electric heating systems are to be used (and assuming that the school will be all-electric), 277/480-volt (265/460-volt) electrical systems will usually be applicable and desirable.

● 1205.00 The conductor insulation for supply connections and other field wiring for electric heating apparatus should be specified. Insulation with a higher temperature rating than TW is usually required in these instances.

● 1206.00 In toilet rooms, locker rooms and any other such areas subject to wetting or washing down, electric heating apparatus should not be placed near the floor.

● 1207.00 With regard to roof-top heating units, please refer to Item M-1107.00.

M-1300.00 Ventilating

1301.00 The Division of School Planning, recognizing the importance of proper ventilation, recommends that consideration be given to providing mechanical ventilation for all the occupied spaces in a public school building.

● 1302.00 Mechanical ventilation may be provided by means of a separate intake and exhaust system, or by means of integration with the heating-cooling system. The latter method is much preferred.

● 1303.00 When ventilation air is introduced into a space adequate provision must be made for air relief.

● 1304.00 Variable volume ventilation systems, whether separate or integrated with heating or cooling equipment, are very useful in the North Carolina climate.

● 1305.00 Mechanical ventilation is vital to gymnasiums, locker rooms, dressing rooms, certain storage rooms, laundries, toilet rooms and janitor's closets.

● 1305.01 It is appropriate to provide for year-around, timed operation of ventilation equipment for areas where uniforms are stored.

● 1305.02 Mechanical ventilation (exhaust) is recommended for any toilet room, whether or not a window is provided, that has more than one water closet.

● 1305.03 A sound trap should be installed in a duct system serving two or more toilet rooms.

1306.00 Food storage room ventilation: This is necessary, and should be done by means of introducing outside fresh air near the floor and expelling exhaust air through the roof, all by gravity flow.

● 1307.00 Paint spray rooms demand special treatment with respect to ventilation and safety requirements. Paint spray booths, commercial type, are recommended. If one is not to be used but a paint spray room is desired, the engineer should be careful to investigate this matter thoroughly with respect to regulations and codes.

M-1400.00 Air Conditioning (Cooling)

1401.00 Cooling is recognized as a desirable and useful feature in public schools. It is felt that cooling should be considered for schools or portions of schools that will be used for either full or part-time summer school programs.

● 1401.01 Cooling should be provided for all interior classrooms without exception.

● 1402.00 Any of the types of cooling systems that conform to good engineering practices are acceptable. The type of system used, however, should be given careful consideration with respect to each individual case. The economics of both the first cost and the operating and maintenance cost should be analyzed. Maintenance capability should be evaluated. Location of the school might be an important factor. The engineer should study these and other considerations in the light of the owners' best interests before proceeding with design.

1403.00 It is looked upon as good practice to consider provisions for future cooling in any new school that is not to have cooling installed initially. This is to say that system design, related equipment and services could all be considered in the light of adding cooling at a later time.

1404.00 Cooling load summaries should be shown on the plans in the same manner as for heating.

● 1405.00 Consideration should be given to providing humidification control in air conditioning systems. This is very important when conditioned spaces are carpeted.

● 1406.00 In central plant A/C systems careful selection of the refrigeration equipment is important. Proper evaluation should be made of capacities, flexibility, space requirements, noise and vibration factors, operating and maintenance costs and etc. Load diversity should be considered where applicable. The type of refrigeration machinery to be used, reciprocating, centrifugal, hermetic or open should be carefully investigated and evaluated.

● 1407.00 Self-contained, unitary A/C equipment is acceptable where applicable. However, such equipment should be very carefully evaluated with respect to life expectancy, capacity limitations, ventilating capability and noise factors.

● 1408.00 Window type A/C units are not recommended, and should be used only as a last resort.

STOKER SIZE SELECTION TABLE

Stokers figured for use in N. C. schools which burn N. C. Specification coal having a density of 44 lb. per cu. ft. and a heating value of 13,500 BTU per lb. Combined stoker and boiler efficiency: 65% up to 2,813 sq. ft. net SBI and 70% over 2,813 sq. ft. net SBI. Note double horizontal line. Piping and pickup: 33% of net load.

The table that follows is designed in such a manner that a proper stoker size can be selected by merely entering Column One, Two or Three with a total attached radiation figure (in btu per hour, square feet of steam or square feet of hot water) and reading from Column Four, Five or Six the coal feed rate.

Caution

It should be noted that figures in this table are based on an assumed piping and pick-up factor of 33%. Depending on the type of building or buildings being heated, whether they are of the finger type or in a campus arrangement instead of being merely square or rectangular, it may be necessary to increase this factor or actually calculate it.

Example

1. Enter Column Two with a total attached radiation of 5,000 square feet of steam.
2. Read maximum coal feed rate necessary for a given stoker manufacturer's equipment in Column Four, Five or Six (169,173 or 185 lbs. per hour).
3. Using the proper manufacturer's catalog, select the next larger stoker which will deliver this required coal feed rate.

Where stokers are selected with high sheave speed or special gear ratios to increase the feed rate, special note of this should be made on the plans and in the specifications.

HOURLY LOAD ON BOILER DIRECT STANDING RADIATION Net SBI Rating			MAXIMUM STOKER RATINGS lb. per hour			
			Design Coal Density	44 lb. per cu. ft.	45 lb. per cu. ft.	48 lb. per cu. ft.
BTU per hour in 1000's	STEAM RADIATION (sq. ft.) 240 BTU per hour per sq. ft.	HOT WATER RADIATION (sq. ft.) 150 BTU per hour per sq. ft.	Stoker Manufacturer	Iron Fireman	Winkler	Anchor Combustioneer Will-Burt
450	1875	3000		69	70	75
465	1937	3100		71	73	77
480	2000	3200		73	75	80
495	2063	3300		76	77	82
510	2125	3400		78	79	85

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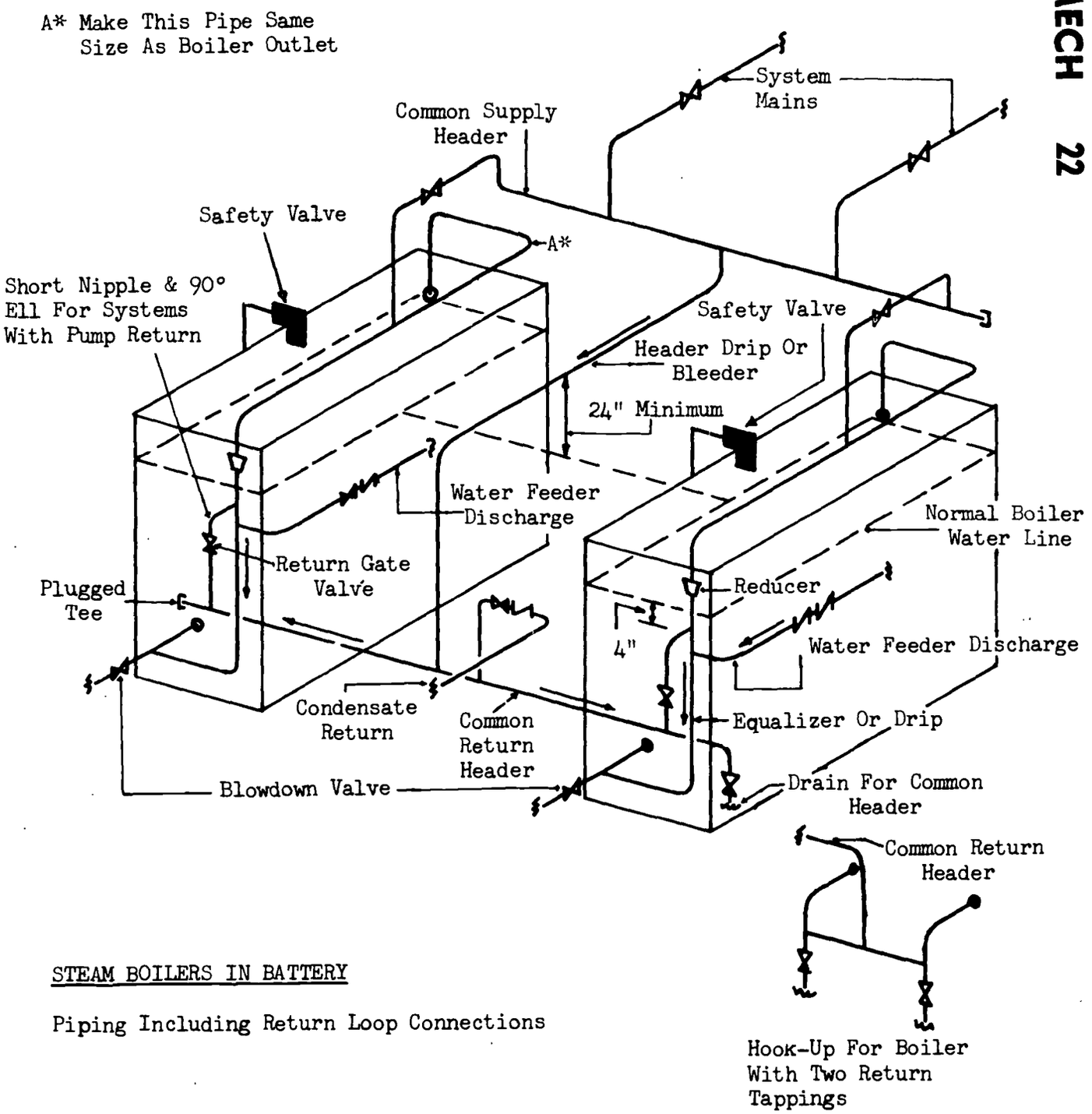
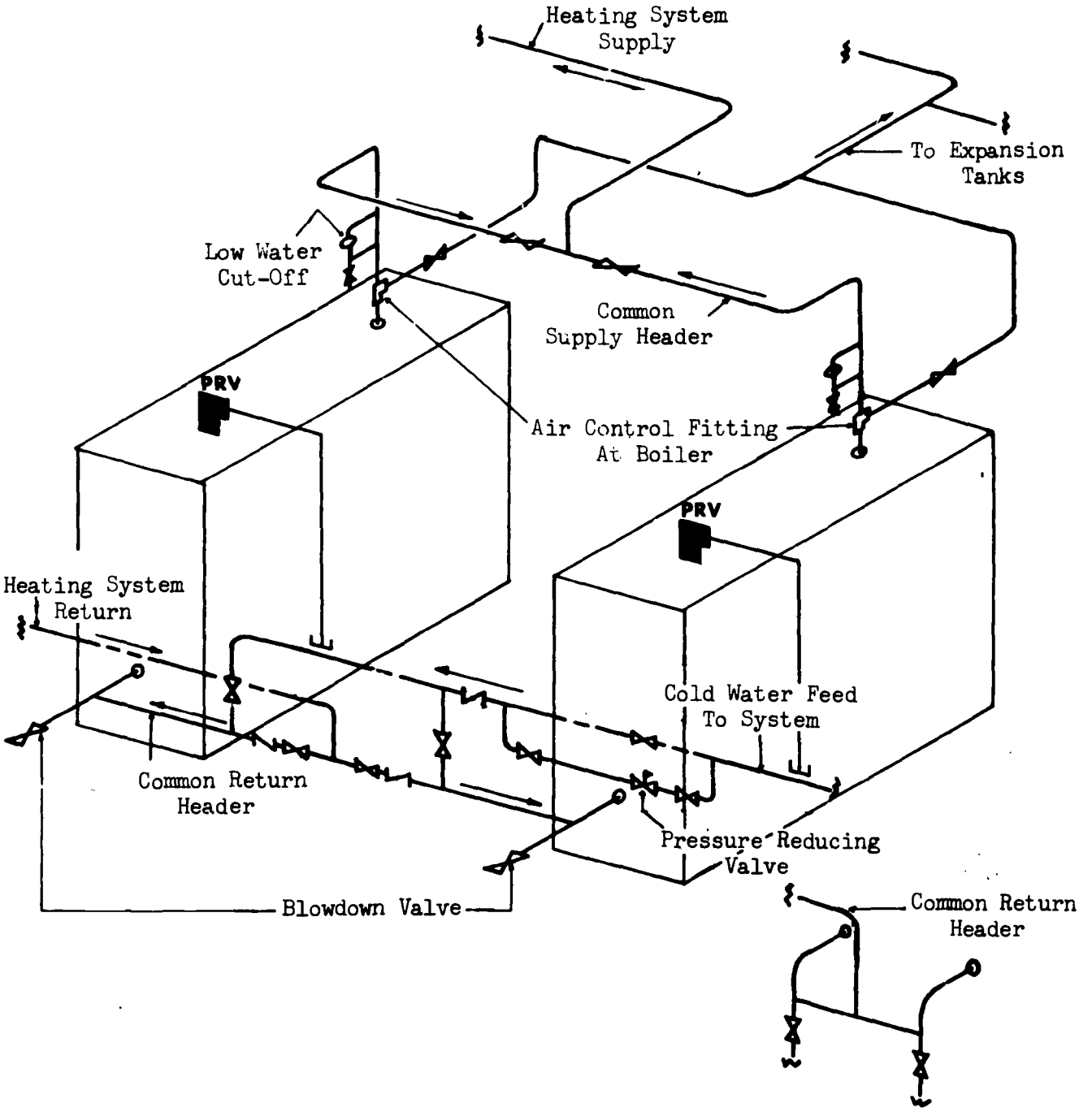
525	2185	3500	80	82	87
563	2343	3750	86	87	93
600	2500	4000	92	94	100
637	2657	4250	97	99	106
675	2813	4500	103	105	112
712	2969	4750	101	103	110
755	3125	5000	106	108	115
788	3281	5250	111	114	121
832	3437	5500	116	119	127
860	3594	5750	122	125	133
900	3750	6000	127	130	139
950	3906	6250	132	135	144
975	4063	6500	138	141	150
1013	4219	6750	143	146	156
1050	4375	7000	148	152	162
1085	4531	7250	154	158	169
1123	4687	7500	159	163	174
1160	4843	7750	164	168	179
1200	5000	8000	169	173	185
1239	5156	8250	175	179	191
1275	5313	8500	180	184	197
1313	5469	8700	185	190	202
1350	5625	9000	190	195	208
1388	5781	9250	196	201	214
1425	5937	9500	201	206	220
1462	6093	9750	206	211	227
1500	6250	10000	212	217	232
1540	6406	10250	217	222	237
1575	6562	10500	222	228	243
1610	6718	10750	228	234	249
1650	6875	11000	233	239	254
1725	7187	11500	243	249	266
1800	7500	12000	254	260	278
1875	7813	12500	265	272	290
1950	8125	13000	275	282	300
2025	8437	13500	286	293	312
2100	8750	14000	296	303	323
2175	9063	14500	307	312	335
2250	9375	15000	317	325	346
2325	9687	15500	328	336	358

2400	10000	16000	339	347	370
2475	10313	16500	349	358	382
2550	10625	17000	360	369	393
2625	10937	17500	371	380	405
2700	11250	18000	381	390	416
2775	11563	18500	392	402	428
2850	11875	19000	402	412	440
2925	12187	19500	412	423	450
3000	12500	20000	423	433	462
3075	12813	20500	434	444	474
3150	13125	21000	444	455	485
3300	13750	22000	466	477	509
3450	14375	23000	487	499	531
3600	15000	24000	508	520	554
3750	15625	25000	529	542	577
3900	16250	26000	550	563	600
4050	16875	27000	572	586	625
4200	17500	28000	593	607	648
4350	18125	29000	614	628	670
4500	18750	30000	635	649	693
4650	19375	31000	656	671	716
4800	20000	32000	678	693	740
4950	20625	33000	698	713	761
5100	21250	34000	720	736	786
5250	21875	35000	741	759	809
5400	22500	36000	762	780	832
5550	23125	37000	783	800	854
5700	23750	38000	804	822	877
5850	24375	39000	826	845	902
6000	25000	40000	847	866	925
6150	25625	41000	868	888	946
6300	26250	42000	889	909	970
6450	26875	43000	910	931	993
6600	27500	44000	932	954	1019
6750	28125	45000	952	974	1040
6900	28750	46000	974	995	1063
7050	29375	47000	994	1018	1085
7200	30000	48000	1015	1040	1108
7350	30625	49000	1037	1062	1130
7500	31250	50000	1058	1083	1152



STEAM BOILERS IN BATTERY

Piping Including Return Loop Connections



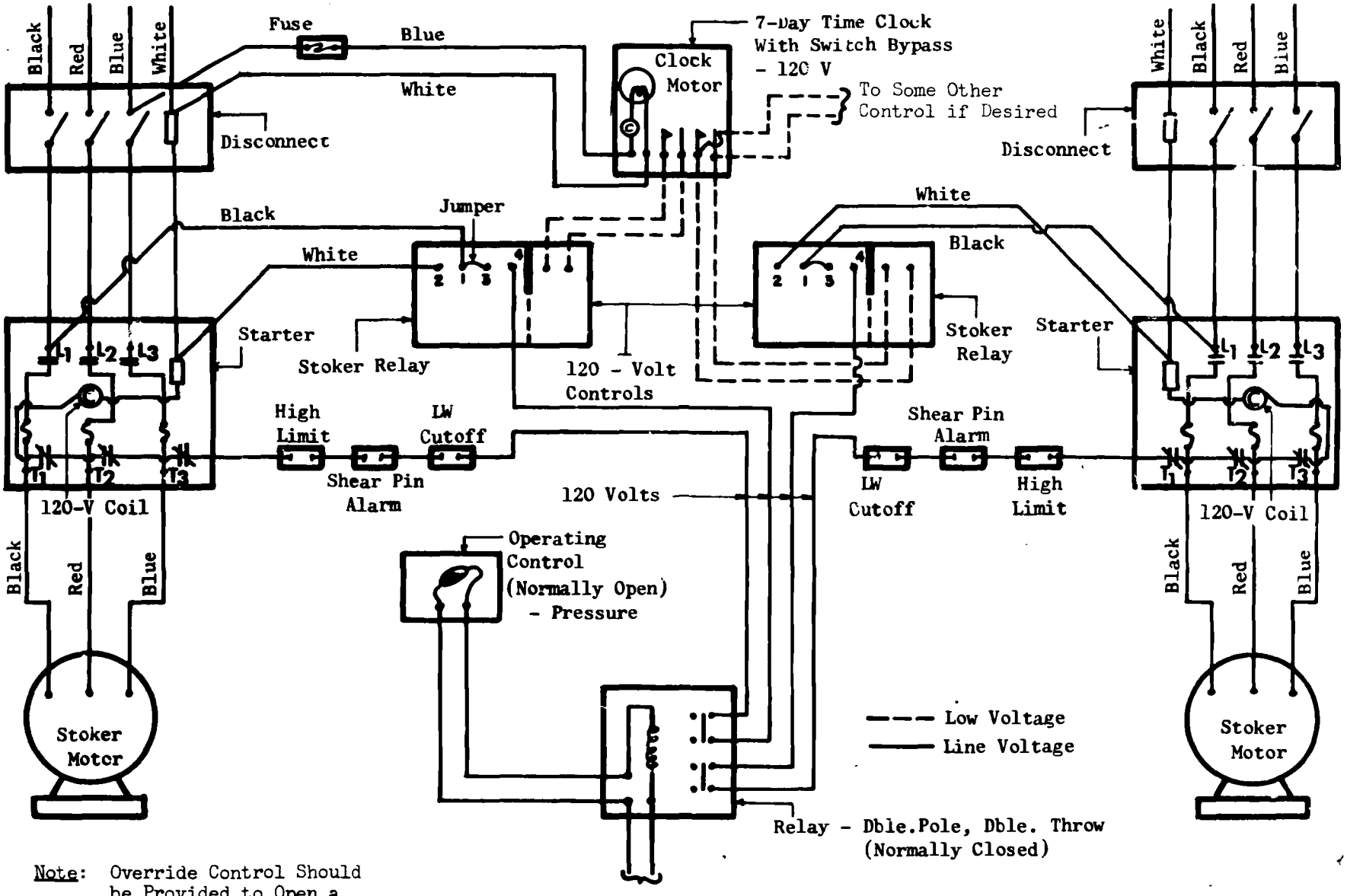
Hook-Up For Boiler
With Two Return
Tappings

● HOT WATER BOILERS IN BATTERY

Piping Arrangement

Division of School
Planning 1969

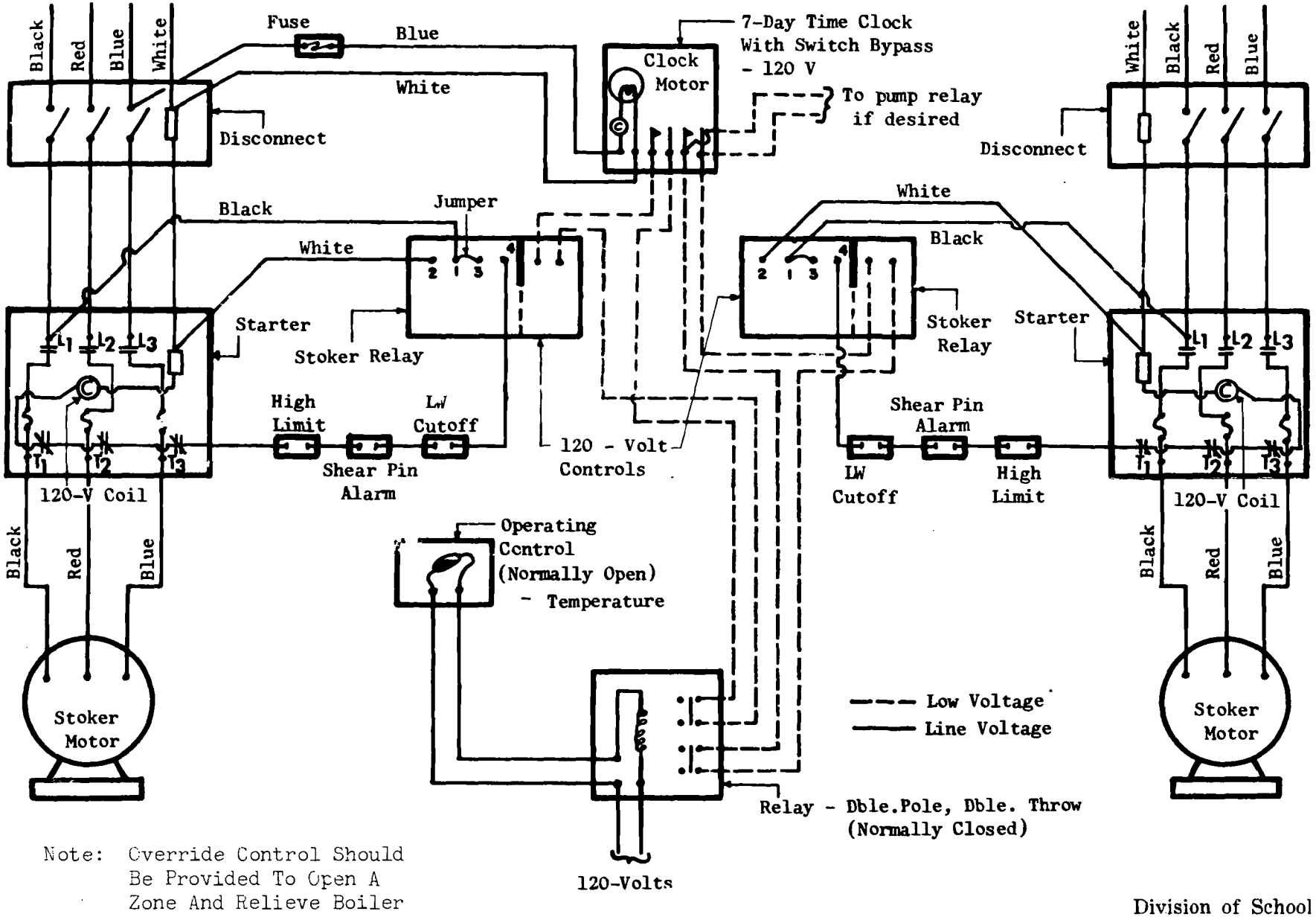
MECH 24



Note: Override Control Should be Provided to Open a Zone and Relieve Boiler Automatically When Necessary

● TYPICAL STOKER CONTROL DIAGRAM - STEAM

Division of School Planning 1969

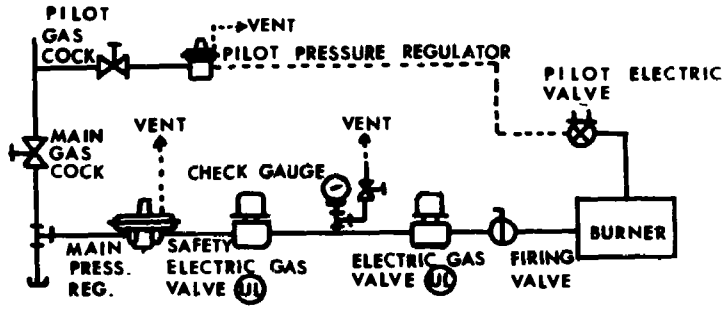


Note: Override Control Should Be Provided To Open A Zone And Relieve Boiler Automatically When Necessary

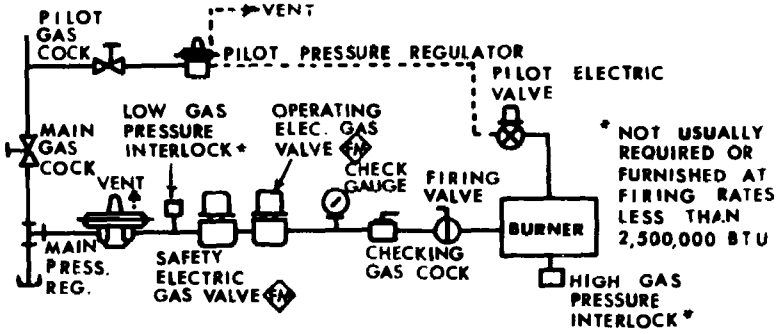
● TYPICAL STOKER CONTROL DIAGRAM - HOT WATER

Division of School Planning 1969

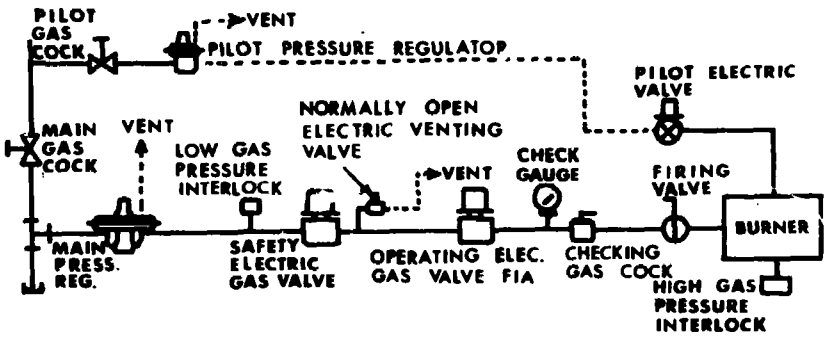
MECH 26



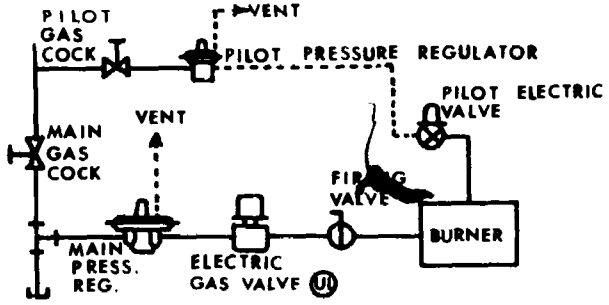
No. 1 U.L. - S.C.I. GAS PIPING GROUP (STANDARD)



No. 2 FACTORY MUTUAL GAS PIPING GROUP (FM)



No. 3 FACTORY INSURANCE ASSOCIATION GAS PIPING GROUP (FIA)



No. 4 U.L. PIPING GROUP (OPTIONAL)

● SCHEMATIC ILLUSTRATION OF STANDARD PIPING OF GAS GROUPS (TRAINS)

NOTE: As a reference for the application of gas burner controls, the engineer is referred to the Underwriters' Laboratories Publication No. UL 795–1968.

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E-100.00 General

101.00 The electrical plans should include a riser diagram showing service conduit size, service wire size (or bus duct) panels, switches, overcurrent device sizes, transformers (when used in the secondary system), feeder conduit sizes, feeder wire sizes and complete grounding and bonding details.

● 101.01 Grounding and bonding details can best be shown by means of a separate diagram.

102.00 The electrical plans should include a numbered circuit diagram for each panel showing circuit use, circuit wire size, circuit conduit size, phase loads and total panel load.

103.00 The emergency system must be kept separate from all other wiring (NEC 700-17).

104.00 Where wire and equipment is oversized for future expansion or for equipment which may be added in the future, some notation of this on the plans is helpful to everyone concerned.

105.00 The entire system must be color coded. Painting or taping will not be accepted on wire of size number six or smaller (NEC 200-6 and 210-5).

● 105.01 Two sets of colors should be used for color coding dual voltage systems (such as 277/480 and 120/208-volts). Color standardization for the phase conductors should be **red, black** and **blue** for 120/208-volt system, and **yellow, brown** and **orange** for 277 480-volt systems.

106.00 When long runs of wire are used, voltage drop should be considered (independent of spare capacity).

107.00 The electrical plans must bear the seal of the engineer who is responsible for the design and is by law obligated to inspect and issue a Certificate of Compliance upon completion of the project (NCGS 133-1.1).

108.00 All electrical plans and specifications should be coordinated; i.e., heating controls, general lighting and plumbing wiring.

● 108.01 It is recommended that wiring and final connections for the control of mechanical equipment (heating and A/C controls) be a part of the mechanical contract.

109.00 Secondary voltage systems.

109.01 The electrical plans should show the secondary voltage (preferably at the riser diagram).

109.02 Acceptable secondary voltage systems:

109.021 120 208-volts, 3-phase, 4-wire, wye.

109.022 277 480 (or 265/460)-volts, 3-phase, 4-wire, wye.

109.023 120 240-volts, 1-phase, 3-wire (refer to next item below).

109.024 The single-phase system is acceptable only when the school is and will remain very small, for a small addition that is served separately or when it is impossible to get a three-phase system.

● 109.025 Delta type systems (such as 120/240-volt, 3-phase, 4-wire) are not desirable, and should be used as little as possible. One proper application might be the use of a 480-volt, delta service for distribution from which transformation to wye systems will be made throughout the site. Also, in a kitchen or a shop for example, which is served separately and has a high percentage use of 240-volt electricity, the 120/240-volt, 3-phase system could be applicable.

● 110.00 Reference is made to step-down transformers within the secondary system. Details for transformer wiring, grounding and bonding should be shown on the drawings. Attention is called to the diagrams showing typical grounding and bonding that follow in this section.

● 111.00 Locations for step-down (dry type) transformers is important from the stand points of safety and proper operation. Such transformers should never be located in wet areas or areas that are to be washed down by hosing. They should never be placed directly on the floor, but should be elevated to eliminate a possible water hazard. Consideration should always be given to locating transformers in properly ventilated areas. The Division of School Planning feels that such transformers should not be directly accessible to students, but rather should be placed in equipment rooms, closets or similar spaces not frequented by students. Please refer to the NEC, Article 450-21.

112.00 The specifications shall demand that all insulated conductors be marked on the outer covering, giving voltage, type and size so that they can be readily identified after installation.

113.00 There should be shown on the plans a complete electrical summary, either all or in part as is appropriate for a given school, as follows:

113.01 The new load.

113.02 The existing load; where this information is not available, the owner should make arrangements to provide it either by the design consultant or some other means.

113.03 The capacity provided for known future expansion.

113.04 The spare capacity provided if different from Item 113.03.

113.05 The total capacity of the service.

● 114.00 In 20-ampere branch circuit wiring, some circuits are of such length that number ten wire must be used at the beginning of the run to avoid excessive voltage drop.

● 115.00 For general classrooms, one 20-ampere circuit should be used for the receptacles only in one classroom, and nothing else should be on this circuit. This is a minimum requirement. Special classrooms will require different considerations.

E-200.00 Service Drop

● 201.00 The location of the nearest power pole should be shown on the plans. This would be in addition to locating the pad-mounted transformer if one is used.

202.00 The service entrance should be detailed and dimensioned, showing the point of attachment to the structure along with the clearance of service wires over finish grade, drives and roofs (NEC 203-24, 230-46 and 730-19 a).

202.01 Flat roofs are considered as being of the type which can be readily walked upon regardless of the difficulty of gaining access to the roof level.

● 203.00 Connections at the service head must be made in accordance with requirements of the NEC, Article 250-51 (refer to Paragraphs (c), (f) and (g) in particular).

204.00 Attention is called to the sketch entitled "Wiring and Equipment Diagram" which follows in this section.

● 205.00 Underground services are highly recommended, both primary and secondary, and should be used in all cases where possible and justifiable (with respect to cost).

E-300.00 Service Equipment

301.00 All service equipment shall be bonded up to and incuding the first overcurrent device (NEC 250-71).

● 301.01 Specifications should cover bonding, and bonding diagrams should be shown on the plans.

301.02 The bond wire used to carry the fault current of a parallel service, where two or more conduits are using the same jumper, shall be sized on the combined conductor capacity and not on the capacity of one set of conductors (NEC 250-78).

● 302.00 The emergency system shall be bonded up to and including its overcurrent device (NEC 710-7). Minimum size bonding jumper wire is No. 8 (NEC, Table 250-94 (a)).

303.00 Switches, cabinets and cutout boxes of the surface type and metal raceways, boxes and fittings mounted on walls subject to dampness shall not be attached directly to the wall surface but shall have at least a ¼ inch air space between enclosures and the walls or other supporting surfaces (NEC 246-4, 348-4 and 373-2).

304.00 Cabinets and cutout boxes in switchgear shall be increased in size to accommodate extra connections (NEC 310-10, 373-7 and 373-8).

305.00 Grounding

305.01 Each individual building or structure shall have its ground and disconnecting means as required by the NEC (NEC 230-70, 230-76 and 250-24).

305.02 The ground connection shall be to the building water main, and must be accessible (NEC 250-112). Point of attachment should be shown on the plan.

305.03 When the ground wire is protected by the use of conduit, the conduit and wire must be bonded together at both ends of the conduit (NEC 250-92).

305.04 The size of the grounding conductor should be shown on the plans.

● 306.00 Electric service equipment should not be located in boiler rooms. This is definitely true if (1) coal fuel is used or (2) if boiler room is below grade. Where oil or gas fuel is used this equipment may be located in the boiler room, but it is

not recommended. Also, and in all cases, electric service equipment located in a boiler room should be in a completely separate enclosure built just to house that equipment.

307.00 Service equipment should be specified as service equipment.

308.00 For equipment interrupting capacity, reference is made to the NEC (NEC 110-9).

309.00 Attention is called to the sketch as indicated in E-204.00 above.

E-400.00 Distribution Equipment

401.00 Panel specifications must include special approved lugs where the conductors are run in multiple.

402.00 Bolt-in type breakers should be used in panels.

403.00 Breakers should be numbered and branch circuits should be installed as shown on the plans; shop drawings of panels should match the plans.

404.00 Do not allow more than one solid or stranded wire under one lug or screw type terminal unless it is approved for such use (NEC 110-13).

405.00 It is recommended that throated, insulated bushings be used on all EMT connectors.

406.00 Spare conduits should be included where spare breakers are provided in flush mounted panels.

407.00 Where the number of overcurrent devices are such that it becomes necessary to provide two panelboards mounted side by side, sufficient information shall be furnished the contractor to permit conduits to be run to the proper enclosure.

408.00 Proper panelboard protection is necessary (NEC Article 384).

409.00 The use of transformers to convert 208-volts to 240-volts for use in home economics ranges is not recommended.

E-500.00 Branch Circuits

501.00 Metal switch and receptacle cover plates are recommended.

502.00 Moistureproof switches and fixtures must be used in wash areas, shower rooms, freezer and refrigeration rooms and other such places that are likely to be subjected to water or moisture (NEC 410-4 and 370-5).

503.00 Do not use flush floor-type receptacles in kitchen or like places subject to washing down and mopping.

504.00 At least one duplex outlet is needed in the boiler room.

505.00 Junction and pull boxes, as a minimum, shall be sized according to Code (NEC 370-18).

506.00 A multi-wire branch circuit, as defined by the NEC, Section 210-4, shall be connected in such a manner that the neutral will not carry more than the maximum load of any one of the "hot conductors" in the circuit.

507.00 All locknuts must be tightened during installation (NEC 300.10).

508.00 Do not load branch circuits to more than eighty percent of their rated capacity (NEC 210-23 b).

509.00 Fluorescent fixtures mounted on combustible, low density, cellulose fiber board shall be installed as required by the Code (NEC 410-74 b).

510.00 The NEC requires that a minimum of three (3) watts per square foot of floor area in branch circuit capacity, for lighting, be provided in school classrooms (NEC 220-2).

511.00 The three (3) watts per square foot figure must be increased by 25% where required by the Code (NEC 220-2 a; classrooms are considered continuous duty with respect to lighting).

E-600.00 Motors and Equipment

601.00 Where raceway flexibility is desired at the point of connection to the motor or piece of equipment, flexible conduit must be installed in accordance with Code requirements (NEC 350-3 and 334-8).

602.00 Thermal overload protection shall be provided for every motor as required by Code (NEC 430-32).

● 602.01 Running overcurrent protection for three-phase motors must be provided in each phase, all as required in the NEC, Article 430-37.

603.00 Each motor shall be within sight of its disconnecting means. More than fifty feet is considered out of sight. (See the NEC, 430-4, 430-86 and 430-106).

604.00 480- or 460-volt equipment is not recommended for kitchen equipment. The only exception to this is the booster heater for boosting hot water temperature for use in dishwashing equipment.

605.00 All electrical devices, appliances and equipment used in public schools must have Underwriters' Laboratories approval as required by NCGS 66-25. Such approval shall be called for in the specifications.

● **E-700.00 Emergency Lighting, Systems and Power**

● 701.00 Emergency and exit lighting must conform to requirements of the NCSBC. Attention is directed to Section 1124—Illumination of Exits and Section 1125—Exit Signs.

702.00 Numerous plans are submitted to the Division of School Planning incorporating emergency and exit lighting systems that do not conform to Code requirements because of errors or omissions. Engineers and architects are encouraged to become familiar with Code requirements.

703.00 Exit lights should be of very low wattages.

704.00 Three-way and four-way switches cannot be used in the emergency system (NEC 700-18).

705.00 Manually operated switches for the exit and/or emergency system should be accessible only to authorized personnel (NEC 700-19).

706.00 The emergency system shall not be controlled from the stage of an assembly area (NEC 700-19).

707.00 With reference to Item 701.00 above, emergency lighting must be provided in accordance with Code requirements. In particular, cafeterias, gymnasiums, auditoriums and other assembly areas that will accommodate more than 100 persons must have emergency illumination.

● 708.00 Fire alarm systems are required for public school buildings. Attention is called to the NCSBC, Section 1126.

● 709.00 Automatic smoke detectors are necessary and/or applicable in public school buildings. Designers are referred to and should become familiar with the NCSBC Section 1127 and Section 1117 (specifically 1117.1).

● 710.00 Special provisions in the NCSBC can require the application of particular types of emergency power sources. The designing engineer is referred to Table 1125 in Chapter XI of this Code.

E-800.00 General Illumination

801.00 Close cooperation by the architect, engineer and school administrator (s) must be achieved to obtain the good lighting system design necessary for a proper visual environment. There are always at least four factors, directly related to the visual environment, that must be considered when designing the lighting system. These are:
(a) Levels of Illumination
(b) Reflectances (and ranges of reflectances)
(c) Brightness (and brightness ratios)
(d) Contrasts

801.01 A table of recommended levels of illumination for schools can be found following herein.

802.00 The overall procedure for designing the lighting system might follow such a course as this:
1. Establish desired environment
   a. Brightness and brightness ratios
   b. Colors and textures
   c. Method of daylighting and daylight controls
2. Establish reference task and required illumination levels
   a. General or academic classrooms
   b. Special purpose areas-labs, libraries, shops, etc.
3. Establish general illumination system
   a. Distribution characteristics of light sources
   b. Coordinate with effect of task visibility
   c. Coordinate with total ennironment
      (1) Characteristics of heat and noise production
      (2) Color acceptability

(3) Special and esthetic characteristics
4. Establish supplementary illumination
   a. Chalkboards, special tasks and special areas
5. Establish audiovisual requirements
6. Analyze economics
   a. Capital expense
   b. Maintenance expense
   c. Electrical energy cost

803.00 Outdoor lighting should be done with respect to the owner's desires, adequate lighting of areas used in traveling to and from the building, and for the purpose of discouraging vandalism.

804.00 Athletic field lighting and wiring require some careful thought. In addition to the consideration of lighting intensities, fixture selection and arrangement and fixture quality, the engineer should concern himself with the safety of the installations, and the requirements of both the NEC and the National Electrical Safety Code. Underground distribution is highly recommended and encouraged.

805.00 As an overall reference for this section, please refer to the American Standard Guide for School Lighting (AIA 31-F-1).

● **E-900.00 All-Electric Schools and Electric Heating**

901.00 The decision for the type heating for a school, when considering all-electric energy, should be made by the owner. Accurate and unbiased cost studies should be prepared by the engineer and architect when directed. The Division of School Planning would welcome the opportunity to share in analyzing such studies.

902.00 For all-electric schools, those using electricity for space heating, it is recommended that 277/480 (or 265/460)-volt systems be used for the secondary voltage. It is felt that this voltage is justified economically in all cases unless the school is very small, and will definitely remain so. Due regard must still be given to safety, and the qualifications of school maintenance personnel.

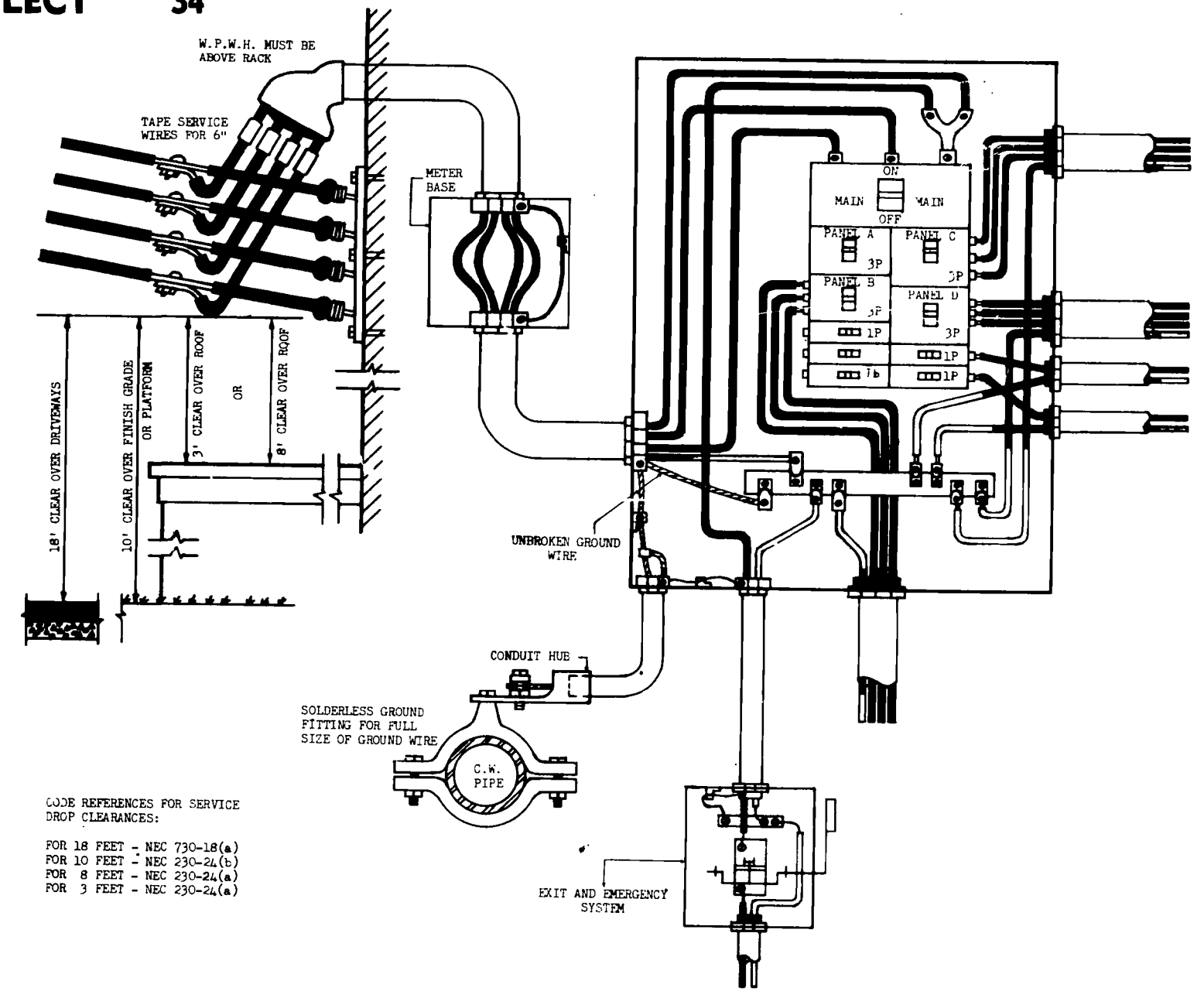
903.00 Where 277/480 (or 265/460)-volt systems are used for secondary voltage, it is recommended that these voltages be used, within reason, to the fullest extent possible. That is, they are recommended for (1) lighting, (2) water heating, (3) space heating (when electric space heating has been chosen) and (4) larger motor loads where practicable. Proper and adequate equipment grounding, for safety purposes, must be clearly defined.

● 903.01 Attention is directed again to the consideration of using 277/480 (or 265/460)-volts electricity for kitchen equipment (refer to Item E-604.00). With regard to economics, operation and maintenance and upkeep, the Division of School Planning recommends against the use of these voltages for kitchen equipment. In the best interests of the owner, both initially and long range, the engineer should carefully evaluate this matter. This Division recommends the use of 120/208 or 120/240-volts electricity for kitchen equipment. The availability of replacement parts is an important consideration in this matter.

904.00 All instructional shop equipment must still be served by the lower voltages such as 120/208-volts.

905.00 All electrical space heating equipment must bear the Underwriters' Laboratories approval (NCGS, Chapter 66, Article IV).

ELECT 34



CODE REFERENCES FOR SERVICE DROP CLEARANCES:

FOR 18 FEET - NEC 730-18(a)
FOR 10 FEET - NEC 230-24(b)
FOR 8 FEET - NEC 230-24(a)
FOR 3 FEET - NEC 230-24(a)

WIRING AND EQUIPMENT DIAGRAM

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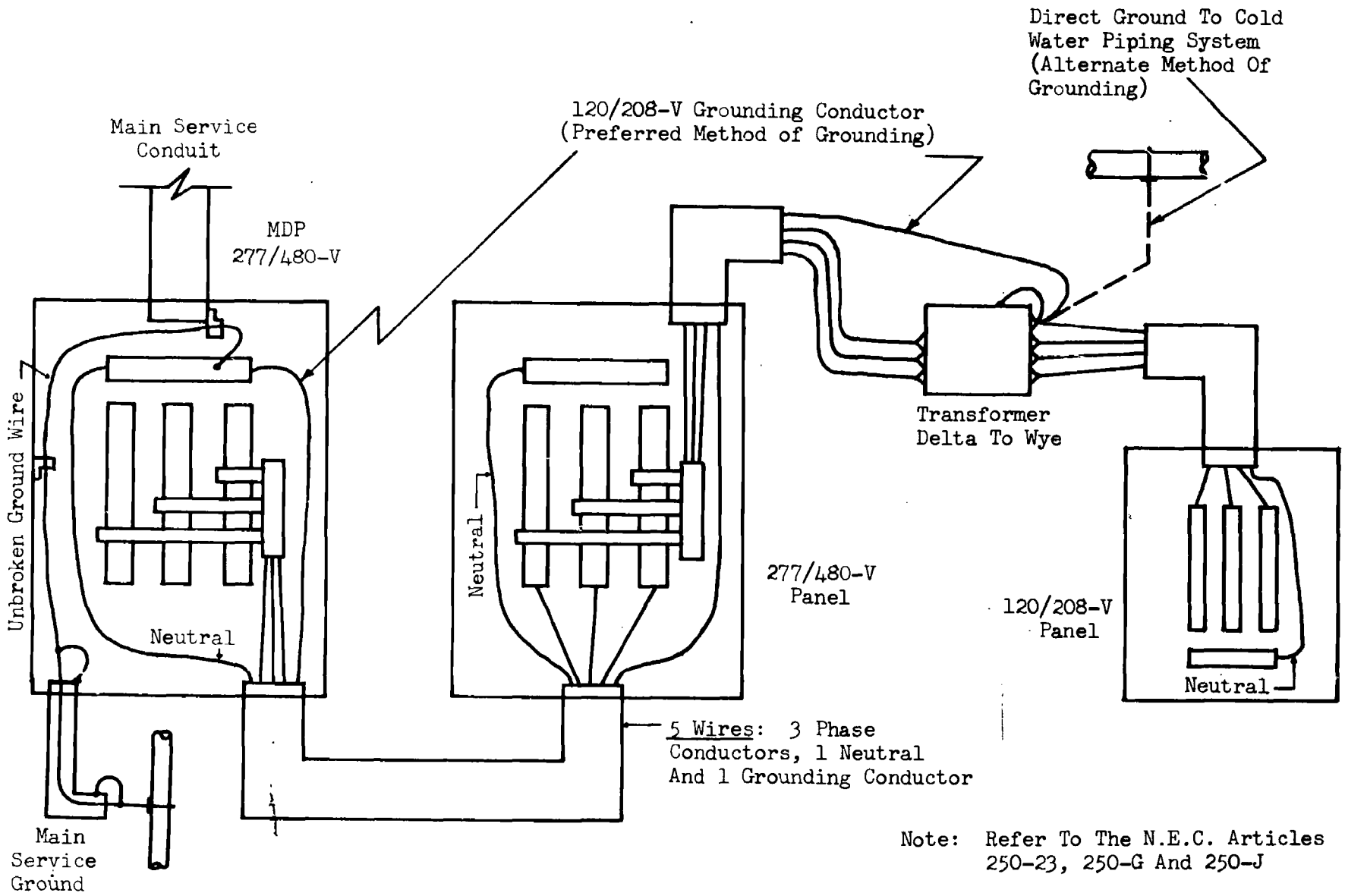

277/480-VOLT AND 120/208-VOLT SYSTEMS SHOWING GROUNDING METHODS - THIS DIAGRAM IS FOR ONE BUILDING ONLY ON THE SITE

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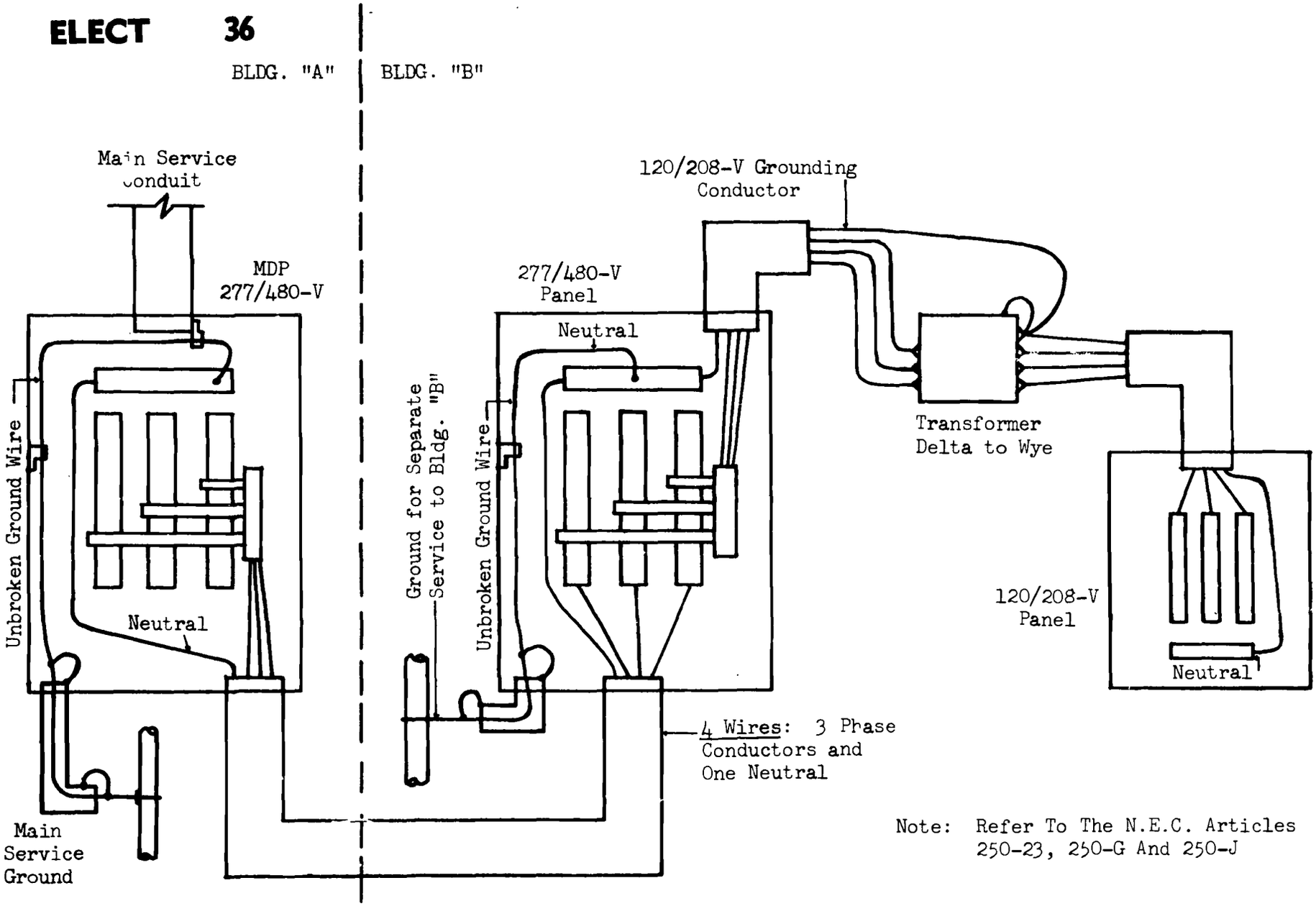
ELECT 36



Note: Refer To The N.E.C. Articles 250-23, 250-G And 250-J

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277/480-VOLT AND 120/208-VOLT SYSTEMS SHOWING GROUNDING METHODS - THIS DIAGRAM IS FOR MORE THAN ONE BUILDING ON THE SITE

TYPICAL ELECTRICAL SUMMARY

(Refer to Item E-113.00)

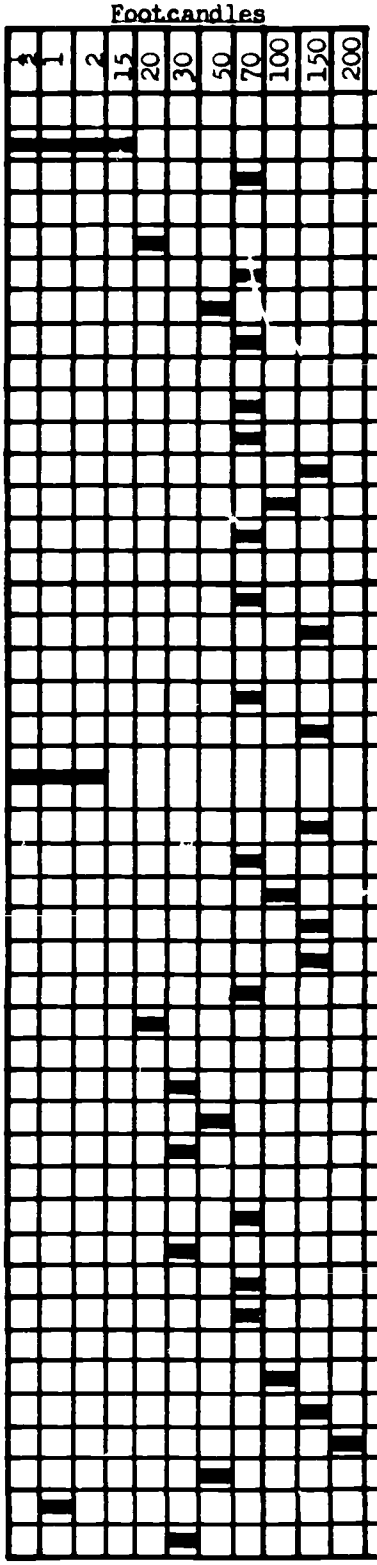
ELECTRICAL LOAD SUMMARY

(A) SERVICE

120/208-Volts, 3-Phase, 4-Wire Wye with Full Neutral; 1600-Amp. Switchboard and 1200-Amp. Service Entrance with Empty Conduit to Increase Service Entrance to 1600-Amps.

(B) CONNECTED LOAD	KW		AMPS	
(1) EXIST. BLDG.				
Ltg.	99.0		275	
Rec. & Spares	60.0		166	
Kitchen	142.00		395	
Water Htr.	37.0		101	
Sub-Totals		338.0		937
(2) NEW BLDG.				
Ltg.	45.0		125	
Rec. & Spares	38.0		103	
		83.0		228
Sub-Totals		421.0		1165
(3) FUT. AIR COND. & OTHER LOADS		188.0		520
Totals		609.0		1685

Recommended Minimum Footcandles



ILLUMINATION LEVELS FOR VARIOUS TASKS & LOCATIONS IN SCHOOLS

AUDITORIUMS (seating area only)
Assembly only (Dimming equipment desirable)
Study Halls
CAFETERIAS
Eating only
When used for study halls
Food Displays
Kitchens
CLASSROOMS
Regular classroom work
Art rooms
Chalkboards (Supplementary illumination)
Drafting rooms
Home Economics rooms
Laboratories
General
Close work
Lecture and demonstration rooms
General
Special exhibits and demonstrations
When projection equipment is used (dimming equipment desirable)
Lipreading classrooms
Music rooms
Manual arts rooms
Sewing rooms
Sightsaving classrooms
Typing rooms
CORRIDORS & STAIRS
GYMNASIUMS
General exercising
Exhibition games
Locker and shower rooms
LIBRARIES
Reading rooms and carrels
Stacks
Book repair and binding
Check-in, check-out, catalogs, card files
OFFICES
Regular office work
Acct., auditing, tabulating, bookkeeping, etc.
Cartography, designing, detailed drafting
Conference rooms
PARKING LOTS
TOILETS & WASHROOMS

The level of illumination should be provided on the task regardless of location in the room, or position. The initial value of illumination must be greater than the minimum value to compensate for lamp depreciation and dirt collection on all surfaces. These are recommended standards of the I. E. S.

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