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MINIMUM CHECK LIST FOR MECHANICAL PLANS AND SPECIFICATIONS.

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NORTH CAROLINA STATE BOARD OF EDUCATION, RALEIGH

PUB DATE DEC 65

EDRS PRICE MF-$0.25 HC-$1.48 35P.

DESCRIPTORS- *CONTROLLED ENVIRONMENT, *DESIGN NEEDS, *EQUIPMENT STANDARDS, *SCHOOL CONSTRUCTION, *STATE STANDARDS, AIR CONDITIONING, ELECTRICAL SYSTEMS, HEATING, LIGHTING, PLUMBING, VENTILATION,

THIS BULLETIN 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. THREE LEVELS OF GUIDELINES ARE MENTIONED--(1) MANDATORY BECAUSE OF LAW, CODE, OR REGULATION, (2) RECOMMENDED AS MOST PRACTICAL AND DESIRABLE, WITH DEVIATIONS TO BE SUPPORTED AND CLEARED, AND (3) INCLUDED AS GOOD PRACTICES WITHOUT UNANIMOUS PROFESSIONAL AGREEMENT. THREE MAJOR AREAS ARE COVERED--(1) PLUMBING, (2) MECHANICAL, AND (3) ELECTRICAL. PLUMBING INCLUDES--(1) DRAINAGE AND WASTE, (2) FITTINGS, (3) FIXTURES, (4) WATER SUPPLY, (5) SEWAGE DISPOSAL, (6) INCINERATORS, (7) GAS SYSTEMS, AND (8) GREASE TRAPS. THE MECHANICAL SECTION DEALS WITH--(1) STACH AND BREECHING, (2) BOILERS, (3) STOKERS, (4) OIL BURNERS AND OIL STORAGE TANKS, (5) STEAM AND HOT WATER PIPING, (6) RADIATION, (7) CONTROLS, (8) HOT WATER HEATING SYSTEMS, (9) STEAM HEATING SYSTEMS, (10) GAS BURNERS AND GAS-FIRED BOILERS, (11) VENTILATING, AND (12) AIR CONDITIONING. THE ELECTRICAL AREA CONCERNS--(1) SERVICE DROP, (2) SERVICE EQUIPMENT, (3) DISTRIBUTION EQUIPMENT, (4) BRANCH CIRCUITS, (5) MOTORS AND EQUIPMENT, (6) EMERGENCY LIGHTING, (7) GENERAL ILLUMINATION, AND (8) ALL-ELECTRIC SCHOOLS. SPECIAL FEATURES INCLUDE CHARTS FOR PLUMBING FIXTURES, STOKER SIZE SELECTION, AND ILLUMINATION LEVELS, AND DIAGRAMS FOR PIPING, CONTROLS, AND WIRING. (MM)

February 28, 1966

TO: All Holders of the Division of School Planning
Minimum Check List "Redbook"

FROM: N. K. Lee, Jr., P. E.
Division of School Planning

SUBJECT: Correction to the "Redbook"

Your attention is called to the Mechanical Section Page MECH 11, Item M-107.01. This item should be changed to read as follows:

"Capacities for range hood fans should be in the order of 50 cfm per square foot of hood area."

Please correct your copies of the "Redbook" to read as shown above.

NKL/ja

# MINIMUM CHECK LIST

## FOR MECHANICAL PLANS AND SPECIFICATIONS

DIVISION OF SCHOOL PLANNING • N C DEPT OF PUBLIC INSTRUCTION • 1965

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ABBREVIATIONS

| | |
|---|---|
| A G A | AMERICAN GAS ASSOCIATION |
| I B R | INSTITUTE OF BOILER AND RADIATOR MANUFACTURERS |
| I E S | ILLUMINATING ENGINEERING SOCIETY |
| N F P A | NATIONAL FIRE PROTECTION ASSOCIATION |
| N E C | NATIONAL ELECTRICAL CODE |
| N F C | NATIONAL FIRE CODES (1964-65 EDITION) |
| N S F | NATIONAL SANITATION FOUNDATION |
| N C B R R | NORTH CAROLINA BOILER RULES AND REGULATIONS (1964 EDITION) |
| N C G S | NORTH CAROLINA GENERAL STATUTES (AS AMENDED TO 1963) |
| N C S B C | NORTH CAROLINA STATE BUILDING CODE (1958 EDITION) |
| S B I | STEEL BOILER INSTITUTE |

## PREFACE

This bulletin 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 bulletin 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 bulletin was developed in 1960 by the engineering staff of the Division of School Planning, assisted by representatives from the Divisions of Insurance and Plant Operation, 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. This revised edition (the second revision) has been reviewed by representatives from these same groups.

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

John Andrews, Board of Health
John Bolen, Professional Engineers of North Carolina
R. B. Boyd, Department of Insurance
E. L. Clodfelter, Department of Labor
T. L. Cordle, Professional Engineers of North Carolina
C. K. Denning, Division of Plant Operation
M. R. A. Johnson, Division of School Planning
C. H. Jourdan, Division of Plant Operation
J. W. Kapherr, Professional Engineers of North Carolina
N. K. Lee, Division of School Planning
W. H. Price, Division of School Planning
Charles Reed, Division of School Planning
G. B. Rottman, Professional Engineers of North Carolina
D. E. Rouse, Professional Engineers of North Carolina
O. F. Smith, American Institute of Architects
J. F. Stamey, Board of Health
L. S. Thompson, Division of School Planning
W. P. Wells, Professional Engineers of North Carolina

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 do 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

December, 1965

# ORGANIZATION CHART

## State Services of the North Carolina Public Schools

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**GOVERNOR**

**LT. GOVERNOR** | **STATE TREASURER** | **STATE SUPERINTENDENT** (MEMBER & SECT'Y.)

AND 10 MEMBERS APPOINTED BY THE GOVERNOR AND CONFIRMED BY THE GENERAL ASSEMBLY FORM THE

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- Trades and Industries
- Veterans Education
- Vocational Materials Laboratory

**VOCATIONAL REHABILITATION**

- Administration
- Counseling
- Supervision

**COUNTY AND CITY ADMINISTRATIVE UNITS**

**P-100.00 Drainage and Waste**

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

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

103.00 The location of the sewer connection shall be shown on the plans. This connection must show where sewage is carried to a municipal system or an on-site disposal system.

104.00 Exterior cleanouts should be set in a concrete pad, level with surrounding grade.

105.00 A water switch should be installed in connection with garbage disposals.

106.00 Floor drainage shall be provided for the boiler room, and for a mechanical equipment room containing any equipment using water or steam.

107.00 The plumbing plan 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 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.

108.01 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.

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

**P-200.00 Fittings**

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

202.00 Flush valves should be installed high enough to prevent foot operation, and vertical run of the supply pipe should be firmly secured to the wall.

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 A pressure relief valve is required on hydro-pneumatic pressure tanks.

**P-300.00 Fixtures**

301.00 Lavatories should be acid-resisting, and have rigid supplies. Also, strainers only (no pop-up or plug) should be used in lavatory wastes in public toilets.

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 should be located in the kitchen area for handwashing.

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

304.00 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.

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

306.00 Countertop sinks should have ledges with holes to receive faucets. Faucets should not be mounted in counter tops.

307.00 Supplies (pipe, values and fittings) that are concealed, such as for countertop sinks, do not need to be the rigid type, and need not be plated.

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

309.00 Wall-hung type urinals are recommended.

309.01 Strainers are recommended for urinal wastes.

**P-400.00 Water Supply** (See also Sections 7 and 8 of the NCBRR)

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 Board of Water Resources for geological information.

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

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

405.00 Any kind of pipe within the building should be insulated where condensation is a problem.

406.00 Water heating equipment shall have ample capacity for dishwashing and showering, and must be placed where components can be easily maintained.

406.01 180-degree water heaters should carry the NSF label, or equal (NSF Standard No. 5).

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

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

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

**P-500.00 Sewage Disposal Systems**

501.00 Locations and principal elevations of connections to public sewer systems shall be shown on plans.

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 plants should include complete details and elevations of all units and appurtenances, including profile from buildings to final point of waste disposition.

**P-600.00 Incinerators**

601.00 An adequate and suitable incinerator is recommended where necessary.

**P-700.00 Gas Systems**

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

702.00 Some of the requirements of this Section 54 are rigid. In particular, the two areas in this publication that are of the 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 and special treatments.

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

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

**P-800.00 Grease Traps**

801.00 Grease traps should be installed only when recommended by the State Board of Health, or when required by local regulation. Applicable directions and instructions should be closely followed.

802.00 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** | | |
| Elementary Boys and Girls | 50″ | If Desired |
| Junior High Boys, Seven through Nine | 56″ | |
| Junior High Girls, Seven through Nine | 54″ | |
| Senior High Boys, Ten through Twelve | 66″ | |
| Senior High Girls, Ten through Twelve | 56″ | |
| In Physical Education Installations | | 1 to 4 |

**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 A hose connection should be provided in the boiler room.

103.00 Floor drainage should be provided for the boiler room.

104.00 Adequate light should be provided in the boiler room.

105.00 Adequate free combustion air shall be provided in the boiler room (NCBRR, Section 9, Rule 17 [b]).

106.00 Motor overload protection should be specified when required by the NEC.

107.00 Gutters are not recommended on range hoods. The range hood should be mounted so that there is a 6'-6" clearance from the floor, and it should be constructed so that there is at least 12" vertical rise before the hood starts to taper. Range hoods should cover the entire area of the cooking equipment, and surround such area by at least ten inches.

107.01 Recommended capacities for range hood fans are from 50 cfm maximum to lesser amounts.

108.00 Adequate make-up air should be provided for exhaust fans.

109.00 Engineers should size all valves on the plans.

110.00 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:

110.01 The new load.

110.02 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.

110.03 The capacity provided for known future expansion.

110.04 The spare capacity provided if this is different from Item 110.03.

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

111.00 Heating design conditions shall be stated on the plans.

112.00 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).

113.00 Boiler room floors should be at or above grade elevation.

**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 general contractor.

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

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.

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.

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 net rating for a steel boiler should be determined on the basis of **one** square foot of heating surface for **fourteen** square feet of equivalent direct radiation.

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 should 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 should be connected in such a manner that the coil cannot be subjected to pressures above those for which it was designed.

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.

## M-400.00 Stokers

401.00 The stoker size shall be based on the use of N. C. specification coal, weighing 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 setting 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 control

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. Heavy oils, and preheating, require higher initial costs and a great deal of maintenance.

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 type primary control should be used for a firing rate greater than 3 gph.

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

504.00 Tank capacities should be relative to the size of the heating plant and to local service and delivery conditions.

505.00 The tank should be thoroughly coated externally with a good protective compound, in the field, just prior to installation.

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.

508.00 Tank should be adequately anchored.

**M-600.00 Steam and Hot Water 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 the 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.

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 Exposed piping outside buildings should be well insulated and protected.

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

606.00 Use expansion fittings, swing joints or expansion loops on long pipe runs.

607.00 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.

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

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

610.00 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 Fin-type radiation using gravity type air flow shall not have more than forty fins per foot.

703.00 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.

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

705.00 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. Manufacturers' recommended pipe size from the breeching to the controller must be followed.

807.00 The installation and wiring of all controls should be specified to be done by fully competent personnel.

**M-900.00 Hot Water Heating Systems**

901.00 Feed or make-up water to the boiler must be fed at the return connection to the boiler (NCBRR, Section 6, Rule 20).

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 A pressure gauge and a separate thermometer are recommended instead of a combination pressure and temperature gauge.

906.00 Air control fittings at boilers and compression tanks are necessary.

907.00 Hot water circulating pumps should have bronze impellers.

908.00 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).

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

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

911.00 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.

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

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

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

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

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

**M-1000.00 Steam Heating Systems**

1001.00 The automatic 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 Burners and Gas-Fired Boilers**

1101.00 Gas burners, for boiler firing, are recommended to be of the atmospheric (non-pressure) type. Factory engineered units, incorporating boiler and burner, are preferred over other types.

1102.00 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 the requirements of the AGA. (Refer also to the NCBRR, Section 9, Rule 9 [b] and diagrams on Pages 69, 70 and 71.)

1103.00 Vents must meet the requirements of the AGA and the NCSBC. Care must be taken that a vent is not so short, with respect to relative building heights and the heights of other objects, that back drafts will occur.

1104.00 Regulations governing the installation of gas systems should be incorporated in the specifications. The authoritative regulation, under NCGS, is the National Fire Codes, Volume 2, entitled "Gases" (refer to Section 54). The requirements of this publication are mandatory. (See also the Plumbing Section, P-700, of this publication.)

1105.00 With reference to Item 1104.00 above, 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 must state these items in detail.

1106.00 Gas piping test should be the same as that referred to in Item P-704.00.

**M-1200.00 Ventilating**

1201.00 The Division of School Planning, recognizing the importance of proper ventilation, recommends that consideration be given to providing mechanical (forced) ventilation to all the habitable spaces in a public school building.

1202.00 Mechanical ventilation may be provided by means of a separate exhaust and intake system, or by means of integration with the heating or heating-cooling system.

1203.00 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.

**M-1300.00 Air Conditioning** (Cooling)

1301.00 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.

1302.00 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. It is felt that a central system, using chilled water (usually a combined hot water-chilled water application), is justified only on the basis of an entire school being used on a full, calendar year schedule, and the owner's ability to pay for and maintain it. Incremental, air-cooled systems are recommended generally because of their flexibility and favorable costs. Such systems are much more adaptable to the economic, operational and maintenance abilities of most of our school administrative units.

1303.00 It is looked upon as good practice to consider provisions for 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 in the future.

1304.00 Cooling load summaries should be shown on the plans in the same manner as for heating.

## THE FOLLOWING PARAGRAPHS ARE RECOMMENDED TO ENGINEERS AND ARCHITECTS FOR USE IN THEIR SPECIFICATIONS

It shall be the responsibility of the contractor to complete the installation of fired or unfired pressure vessels and their safety devices in accordance with the requirements of the latest edition of North Carolina Department of Labor, Boiler Inspection Law, Rules and Regulations. The contractor shall have the equipment which is installed under this contract inspected and approved by the State of North Carolina Department of Labor, Bureau of Boiler Inspection. The contractor shall be responsible for notifying the Bureau of Boiler Inspection in writing at least two weeks prior to the date of completion of all equipment requiring inspection.

Furnish and install in a suitable frame having removable glass cover for posting the certificates of inspection furnished by the North Carolina Department of Labor, Boiler Bureau. Certificates are to be installed in frames and posted in the Boiler Room and/or near the vessel they represent, by the contractor before requesting final inspection of the completed job by the owner, architect and representative of the Division of School Planning.

Final payment will not be made until such a certificate is posted.

## USE OF THE STOKER SIZE SELECTION TABLE

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 1,500 square feet of steam.
2. Read maximum coal feed rate necessary for a given stoker manufacturer's equipment in Column Four, Five or Six (55, 56 or 60 lbs. per hour).
3. Using the proper manufacturer's catalog, select the next larger stoker which will deliver this required coal feed rate.

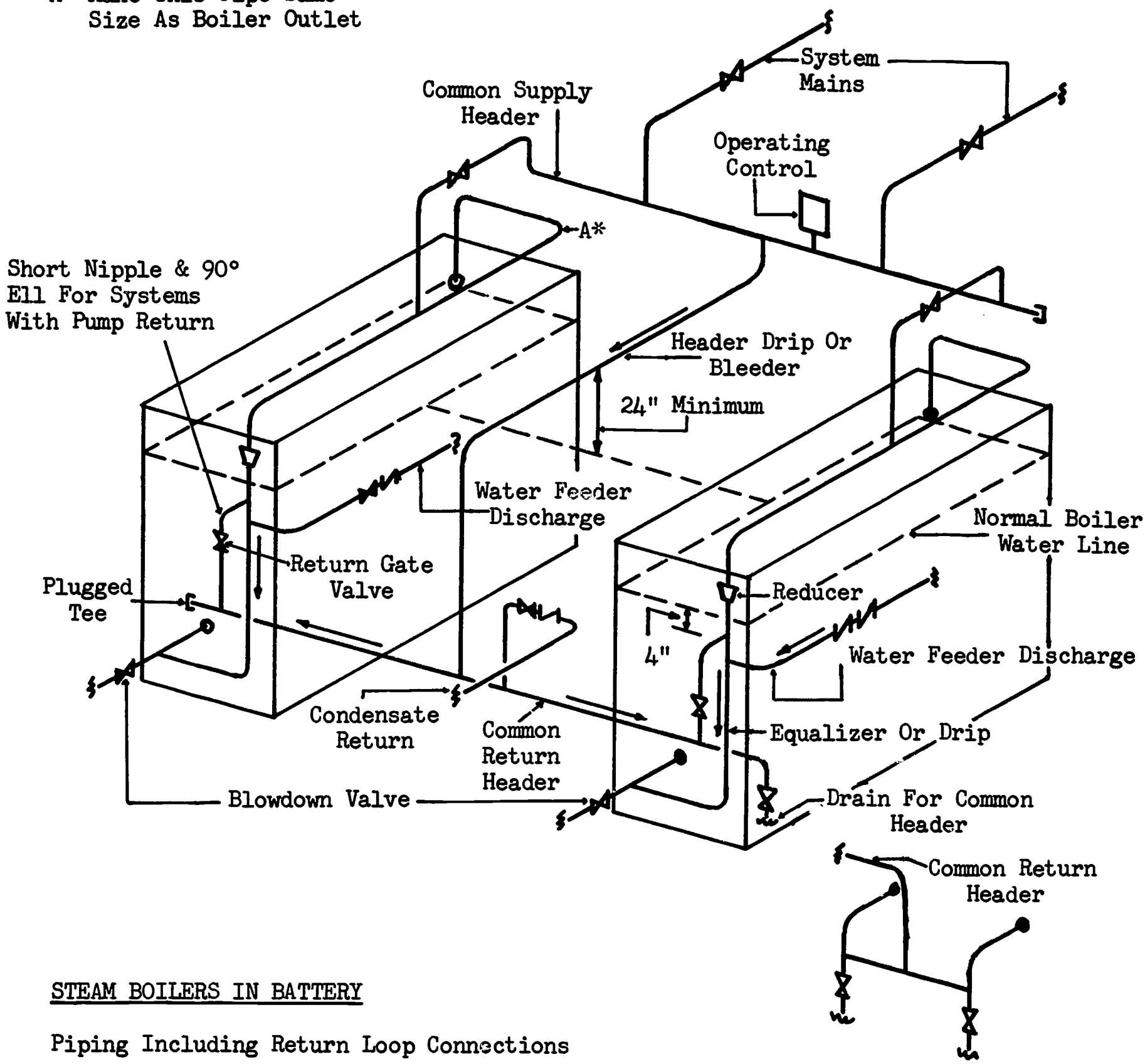
Where stokers are selected with high sheave speed or special gear ratios to increase the feed rate, special note of this should be made on the plans and in the specifications.

# 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.

| 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 |
| 75 | 312 | 500 | | 12 | 12 | 13 |
| 90 | 375 | 600 | | 14 | 14 | 15 |
| 105 | 438 | 700 | | 16 | 17 | 18 |
| 120 | 500 | 800 | | 19 | 19 | 21 |
| 135 | 563 | 900 | | 21 | 21 | 23 |
| 150 | 625 | 1000 | | 23 | 24 | 25 |
| 165 | 688 | 1100 | | 26 | 26 | 28 |
| 180 | 750 | 1200 | | 28 | 28 | 30 |
| 195 | 813 | 1300 | | 30 | 31 | 33 |
| 210 | 876 | 1400 | | 32 | 33 | 35 |
| 225 | 938 | 1500 | | 35 | 35 | 38 |
| 240 | 1000 | 1600 | | 37 | 38 | 40 |
| 255 | 1063 | 1700 | | 39 | 40 | 43 |
| 270 | 1125 | 1800 | | 41 | 42 | 45 |
| 285 | 1187 | 1900 | | 44 | 45 | 48 |
| 300 | 1250 | 2000 | | 46 | 47 | 50 |
| 315 | 1313 | 2100 | | 48 | 49 | 53 |
| 330 | 1375 | 2200 | | 51 | 52 | 55 |
| 345 | 1437 | 2300 | | 53 | 54 | 57 |
| 360 | 1500 | 2400 | | 55 | 56 | 60 |
| 375 | 1563 | 2500 | | 57 | 58 | 62 |
| 390 | 1625 | 2600 | | 60 | 61 | 65 |
| 405 | 1687 | 2700 | | 62 | 64 | 68 |
| 420 | 1750 | 2800 | | 64 | 66 | 70 |
| 435 | 1813 | 2900 | | 67 | 68 | 73 |
| 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 |
| 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 |
| 7650 | 31875 | 51000 | 1079 | 1105 | 1178 |
| 7800 | 32500 | 52000 | 1101 | 1128 | 1201 |
| 7950 | 33125 | 53000 | 1122 | 1150 | 1225 |
| 8100 | 33750 | 54000 | 1143 | 1175 | 1249 |
| 8250 | 34375 | 55000 | 1164 | 1192 | 1260 |
| 8500 | 35000 | 56000 | 1186 | 1215 | 1293 |
| 8650 | 35625 | 57000 | 1206 | 1235 | 1315 |
| 8800 | 36250 | 58000 | 1228 | 1255 | 1339 |
| 8950 | 36875 | 59000 | 1248 | 1279 | 1360 |
| 9100 | 37500 | 60000 | 1270 | 1301 | 1385 |

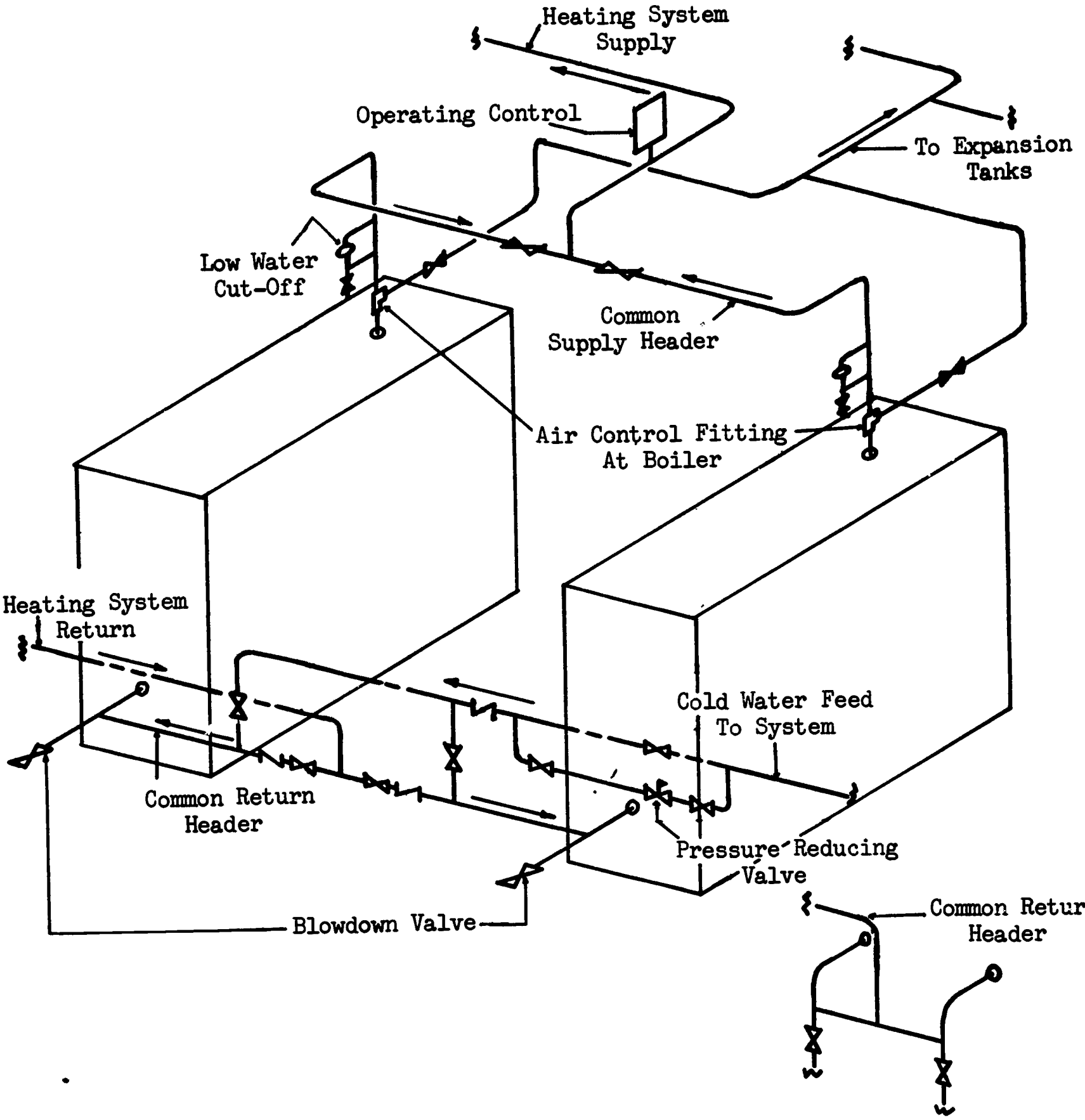



STEAM BOILERS IN BATTERY

Piping Including Return Loop Connections

Hook-Up For Boiler With Two Return Tappings

Division of School Planning 1965





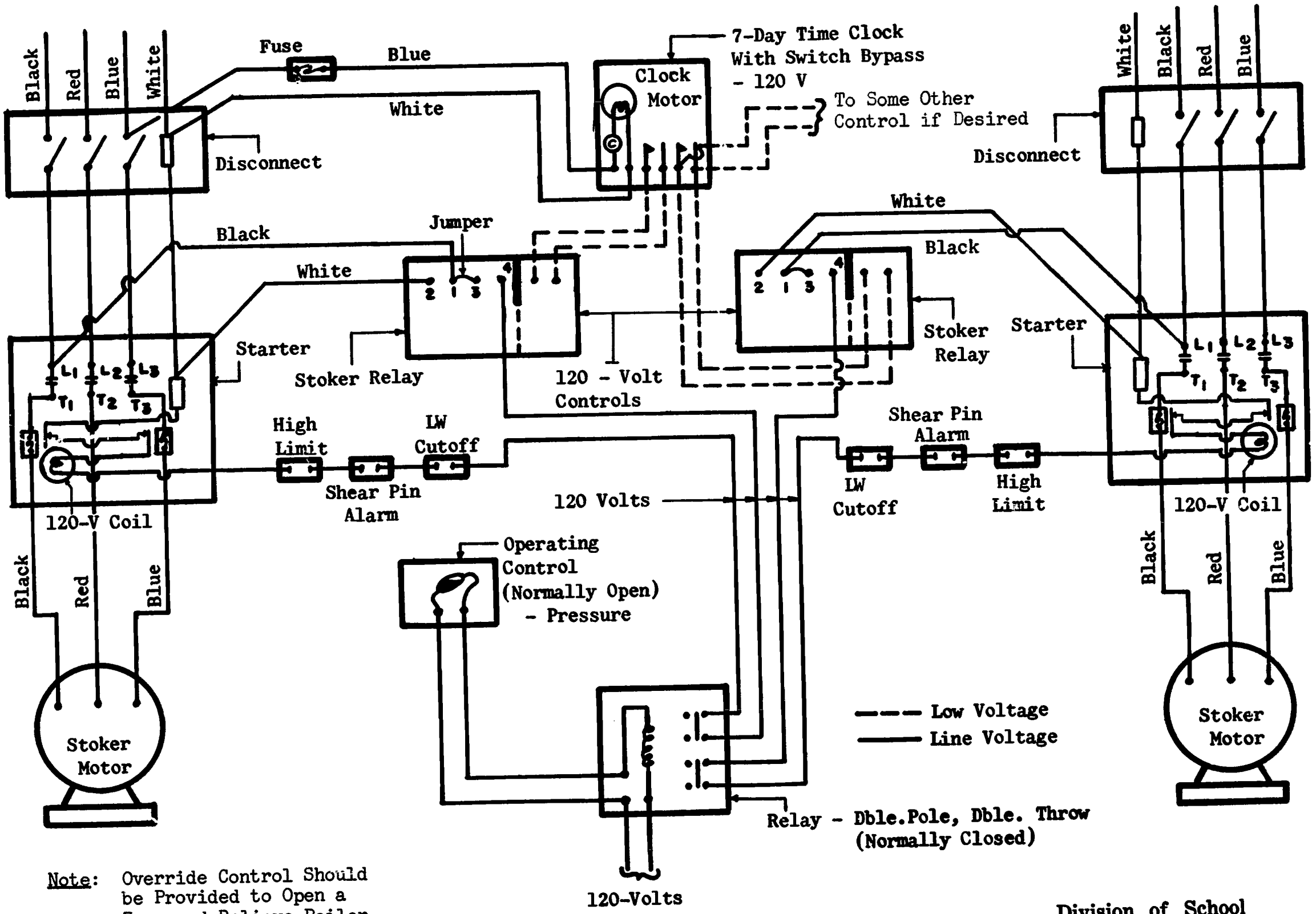


Hook-Up For Boiler
With Two Return
Tappings

HOT WATER BOILERS IN BATTERY

Piping Arrangement

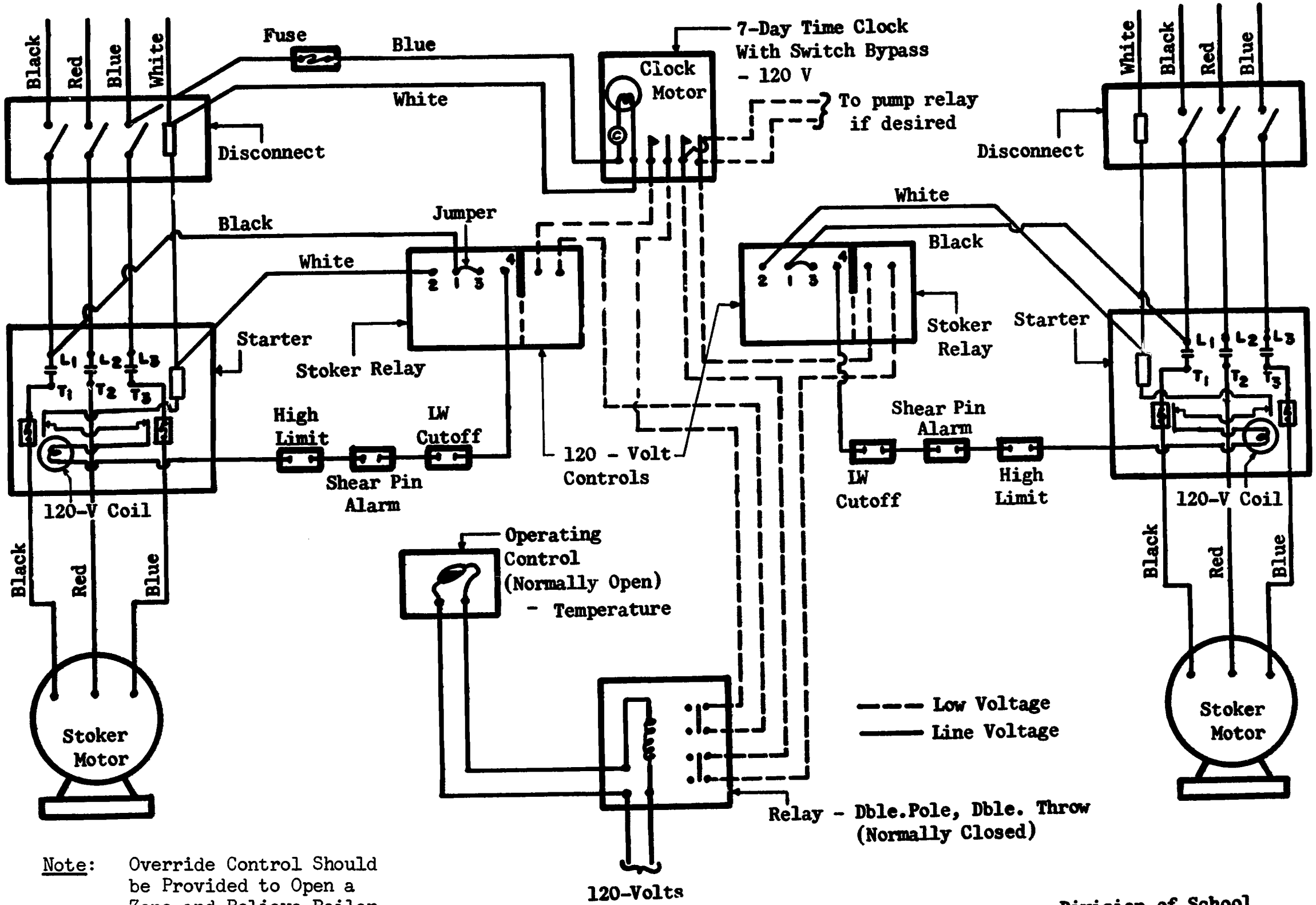
Division of School
Planning 1965




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 1965




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 1965

MECH 25

**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.

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

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).

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.

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 are not desirable, and are acceptable only when it is impossible to get a wye system. The one exception to this is the use of a 480-volt, delta service for distribution from which transformations to wye systems will be made throughout the site.

110.00 Secondary systems above 240-volts.

110.01 277/480-volt systems are not generally recommended for branch circuit wiring (lighting).

110.02 On large projects the use of 277/480-volt systems for distribution, with step-down transformers as necessary, are recommended where economical.

110.03 When using step-down transformers (such as 277/480-volts to 120/208-volts) to make up the secondary system, grounding methods become of primary importance. Each transformer must be properly grounded. Treatment of the grounding, whether feeders are three or four wires, must be in strict accordance with the provisions of the NEC, Article 250. 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 Do not place raceways in the slab beneath the boiler.

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 Adequate light should be provided at panelboards and switches.

115.00 Adequate light should be provided in boiler, mechanical equipment and coal storage rooms.

116.00 In 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.

**E-200.00 Service Drop**

201.00 The location of the nearest auxiliary power pole should be shown on the electrical plans.

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 The connection at the weatherhead shall be above the secondary rack (NEC 230-51).

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

**E-300.00 Service Equipment**

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

301.01 Specifications should cover bonding.

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).

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 the enclosures and the walls or other supporting surfaces (NEC 246-4, 348-4 and 373-2).

304.00 The metallic cabinets and cutout boxes of switch gear 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 own 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.

305.05 The ground clamp shall be sized for the ground wire used.

306.00 Electric service equipment should not be located in boiler rooms.

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 Panels with breakers installed with the "Off" position on top should be avoided.

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

404.00 Breakers should be numbered and branch circuits should be installed as shown on the plans. (Shop drawings of panels should match the plans.)

405.00 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).

406.00 All panels should have typewritten directories.

407.00 Non-metallic bushings must be used on conduit 1¼ inches and above in diameter (NEC 373-6 b).

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

409.00 All unused openings shall be closed (NEC 370-8 and 373-4).

410.00 When using a flush distribution panel, the panel enclosure should be mounted flush with the finished wall (NEC 373-3).

411.00 All distribution equipment should be labeled at main and subdistribution points to designate loads controls, and breakers, switches and overcurrent devices should be labeled.

412.00 Control devices, for the control of special equipment, generally should be located in the area where the equipment is located.

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

414.00 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.

415.00 Proper panelboard protection is necessary (NEC 384-16 a).

416.00 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 Grounding type receptacles must be installed where required by Code (NEC 250-45 and 250-59).

503.00 Moistureproof switches and fixtures must be used in can 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).

504.00 Do not use flush floor type receptacles in kitchens or like places subject to washing down and mopping.

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

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

507.00 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.

508.00 All locknuts must be tightened during installation (NEC 300-10).

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

510.00 Do not design service gutters with fused and unfused conductors in the same enclosure (NEC 230-43).

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

512.00 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).

513.00 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).

514.00 The use of fuses or other devices to protect the ballasts of fluorescent fixtures is recommended.

**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).

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**

701.00 Emergency and exit lighting must conform to requirements of the NCSBC. Compliance with NFPA, No. 101, "Building Exits Code" is recommended and will be acceptable.

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.

**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.

802.00 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

802.01 Recommended and acceptable values for the four factors given in 802.00 may be found in several authoritative publications.

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

803.00 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 on task visibility

c. Coordinate with total environment

(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

804.00 The objective is to provide substantially better lighting systems, which would be to improve the total visual environment. Apparently this can be done by proper collaboration and cooperation of the parties involved at little if any additional costs.

805.00 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.

806.00 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 installation and the requirements of both the NEC and the National Electrical Safety Code. Underground distribution is highly recommended and encouraged.

807.00 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

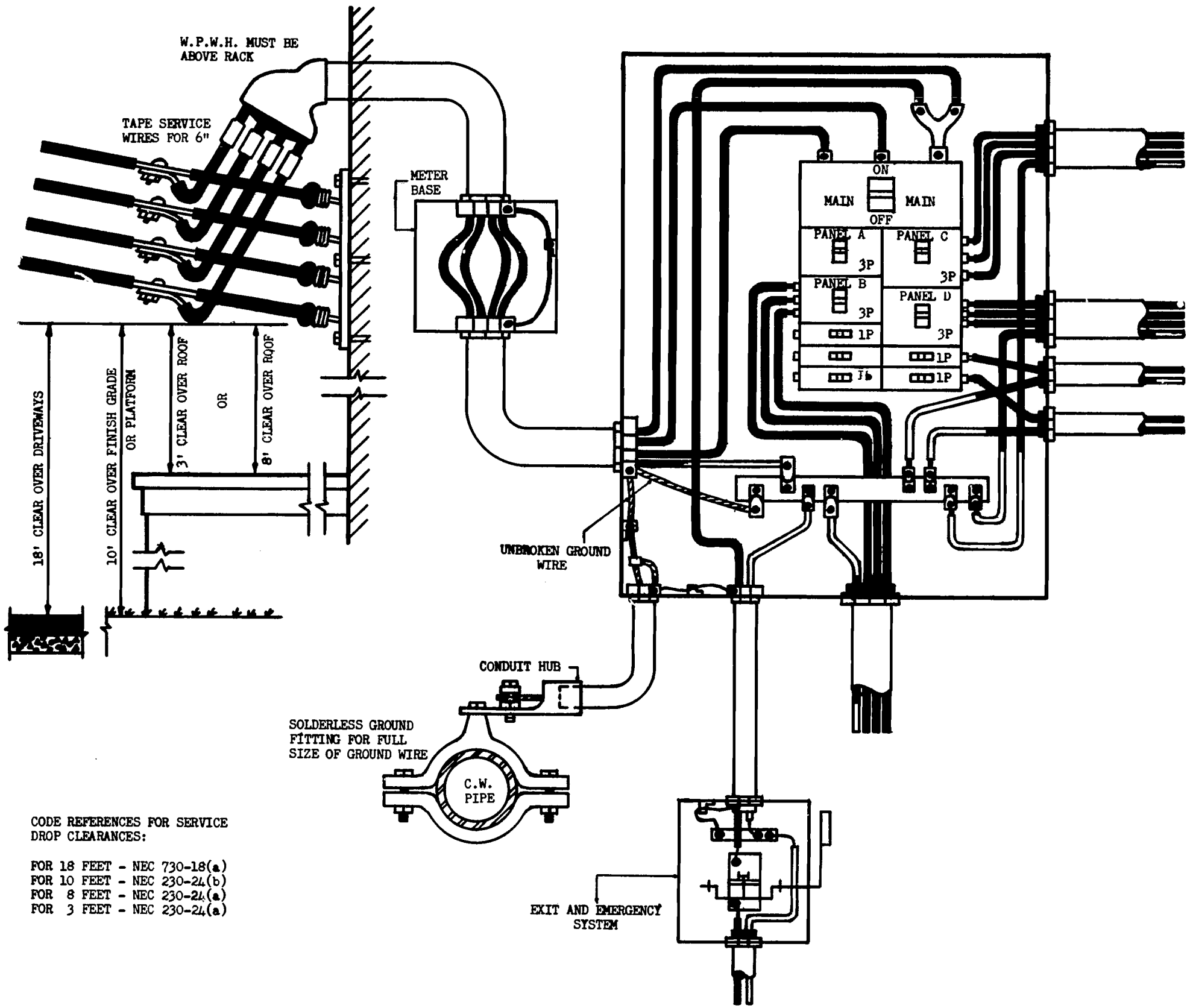
901.00 The decision for the type heating system for a school, when considering all-electric energy, should be made by the owner. Accurate and unbiased cost studies should be prepared by the engineer and architect when directed. The Division of School Planning would welcome the opportunity to share in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

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).




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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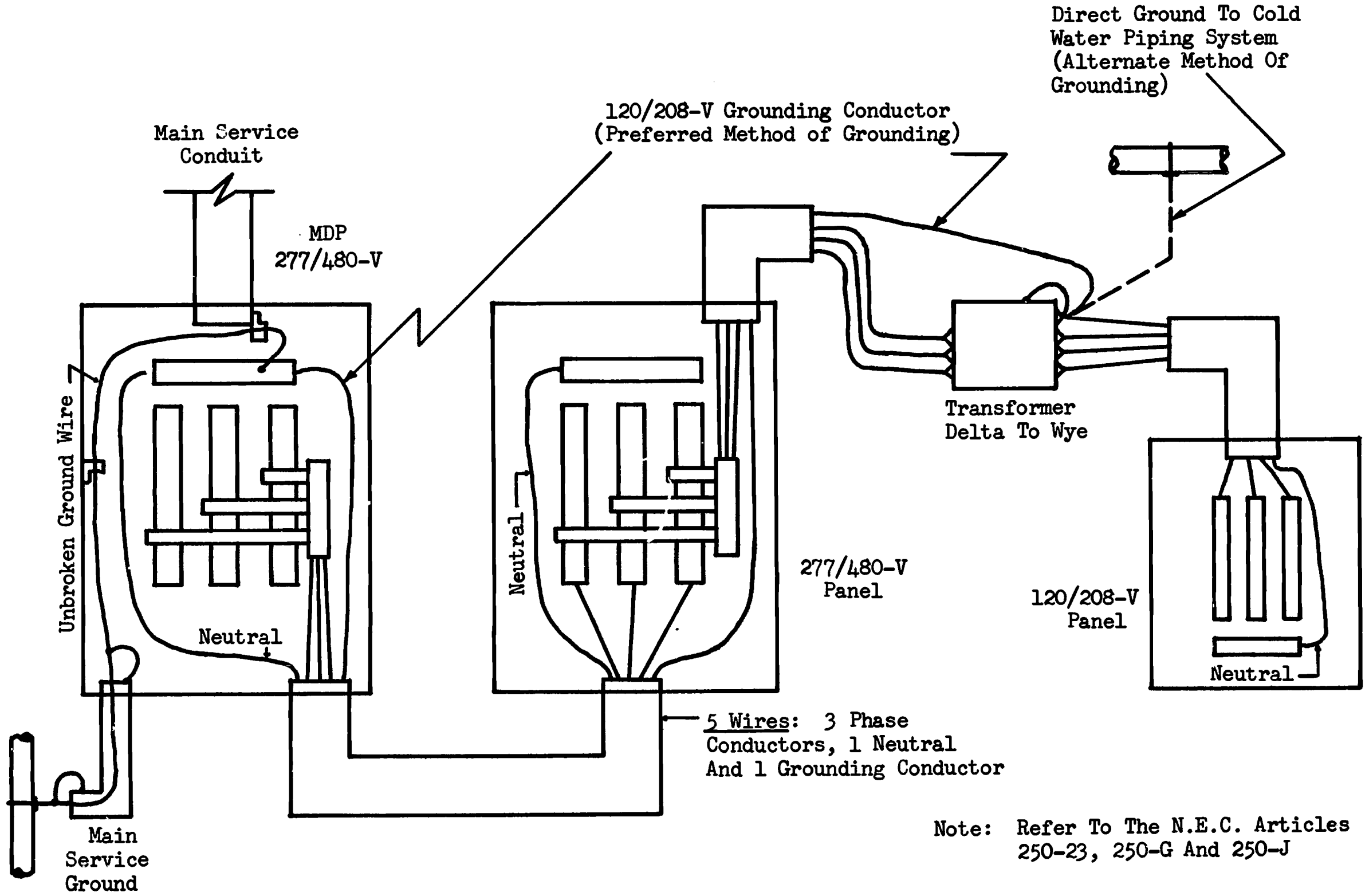


Note: Refer To The N.E.C. Articles 250-23, 250-G And 250-J

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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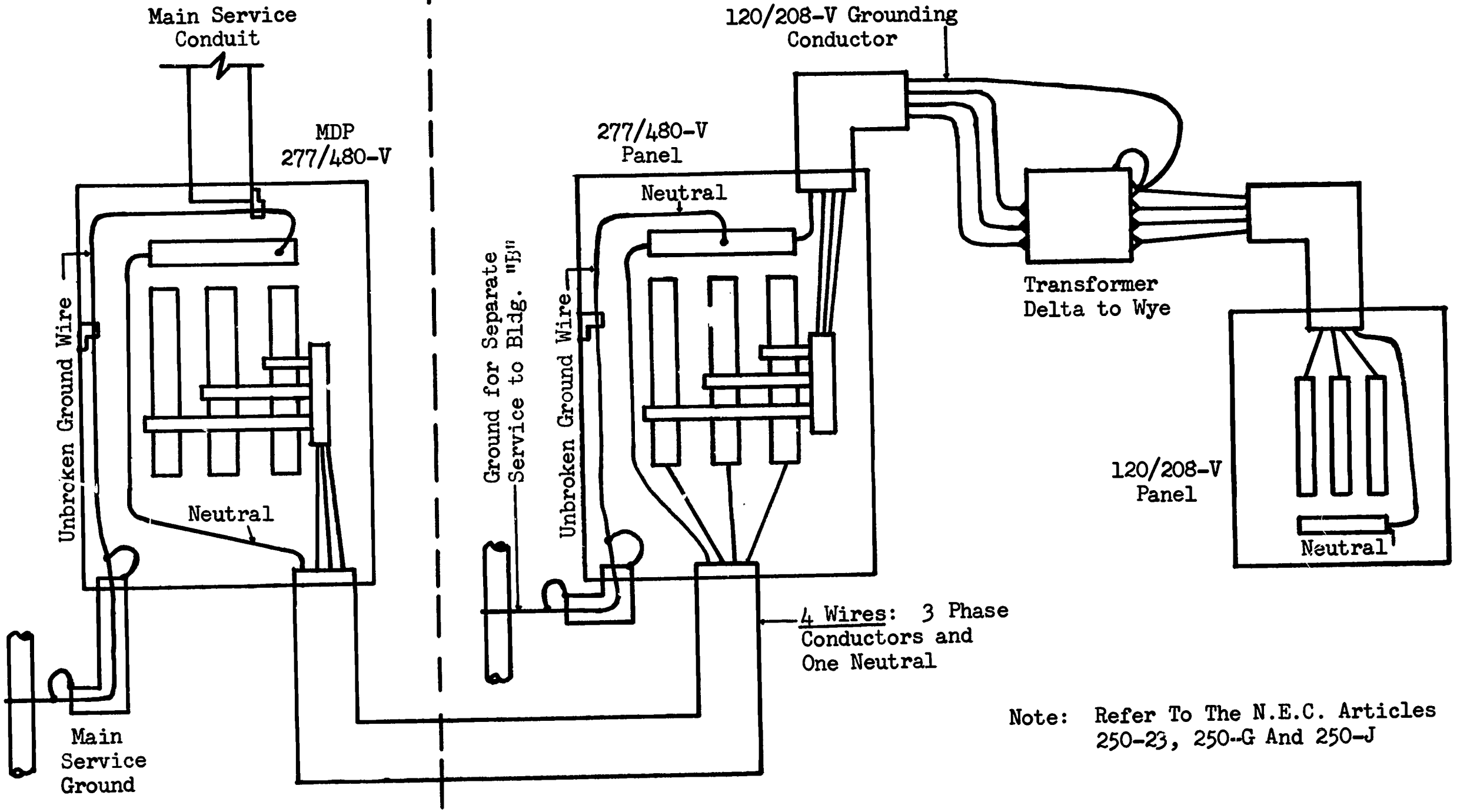
BLDG. "A" | BLDG. "B"




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

ELECT 35

# ELECT 36

## 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 |

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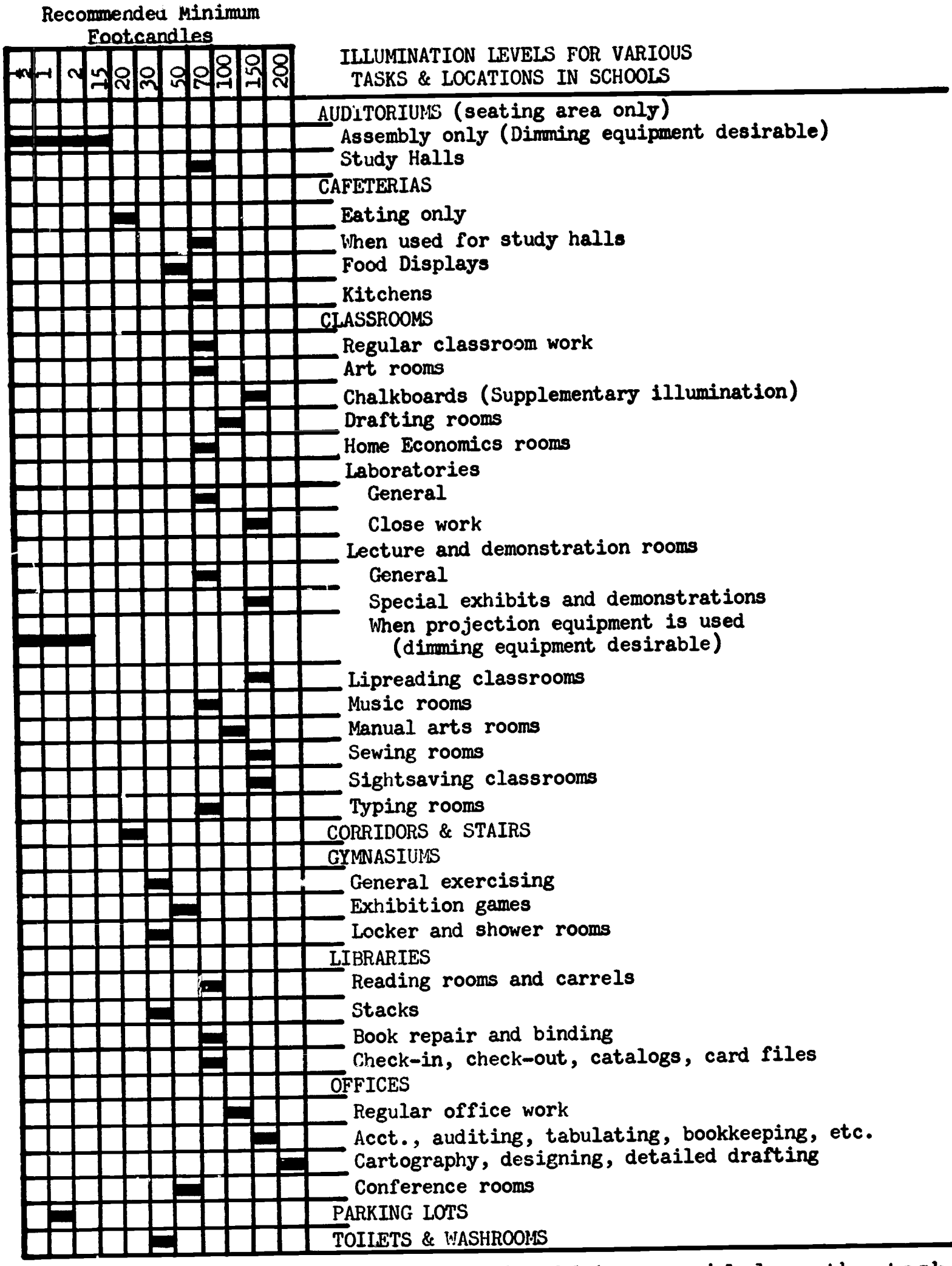


The level of illumination should be provided on the task regardless of location in the room, or position. The initial value of illumination must be greater than the minimum value to compensate for lamp depreciation and dirt collection on all surfaces. These are recommended standards of the I. E. S.

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