BULLETIN NO. LR-8

ELECTRICAL

one of a series of

HOUSING DESIGN NOTES

P H A LOW-RENT HOUSING BULLETIN

U.S. PUBLIC HOUSING ADMINISTRATION

HOUSING AND HOME FINANCE AGENCY WASHINGTON 25, D. C.

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No. 8

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WHICH HAVE BEEN PUBLISHED

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NOTE: Some bulletins will be issued in Parts, of which one or more will be contained in the initial release of each bulletin; other parts will be issued subsequently, from time to time as they are completed.

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ELECTRICAL

INTRODUCTION

This Bulletin is one of a series of eight technical bulletins, designated as Housing Design Notes.

These bulletins are divided into parts, each of which will deal with some element of technical design.

PART I - INTERIOR INSTALLATIONS, is issued with this Introduction. Other parts, including Exterior Distribution, will be issued from time to time as they are completed.

This connected series of Housing Design Notes will contain technical data, notes, observations and recommendations relating to the design problems which are concerned with low-rent housing based on the continuing observation and intensive study of public housing projects which have been in operation for more than ten years. It should be noted that all recommendations are advisory only, except to the extent that they refer to or reflect the mandatory requirements of the current, published PHA Minimum Physical Standards and Criteria.

These bulletins are not offered as textbook material, or with any pretense that they deal exhaustively with any particular subject. In many instances they express opinions which may be subject to challenge, and they are written with a frank acknowledgment that many readers - particularly professionals - may be as well informed in specific fields as the writers - perhaps more so. The PHA believes, however, that careful consideration of the experience recorded and the suggestions offered should result in the avoidance of certain shortcomings which have been noted in existing projects and in profiting from the knowledge of the many good characteristics which have been observed and studied.

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PART I

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ELECTRICAL

PART I - INTERIOR INSTALLATIONS

GENERAL.

Requirements for interior electric light and power for low-rent housing projects differ very little in basic details from those for average private housing developments; the objectives in both cases include the provision of light for safety and well-being, and power for convenience, both with economy in use. In public housing these factors must be especially well balanced since, because of the special need for economy, the use of electricity must be geared to the essential elements of health, safety, and customary convenience, rather than to luxury use.

The foregoing statement should not be misunderstood: the cost of electric wiring is low in proportion to that of the other construction components, the production cost of current tends to decrease in many areas, and the uses found for electric service are increasing at a rapid rate; but, while these factors must be recognized in public housing design, nothing that results in unnecessary expense -- initial or operating -- should be included. Electrical engineers should have an understanding of the problems inherent in low-rent housing, which often requires more than the average skill and ingenuity.

Design based on the minimum requirements of the National Electrical Codes has met the fundamental objectives for safety; essentially, it is a safety code, and any installations made in accordance with its requirements will be safe when properly maintained and not abused; nor does the code disregard the elements of health and economy. Without sacrificing safety, efficiency or convenience, it is necessary in designing low-rent housing to explore all possible means whereby economy in initial cost and operating expense will be achieved.

The information contained in this bulletin reflects experience in the electrical field gained through the operation of many public low-rent housing projects, and it is hoped that it will be of value in selecting the types of equipment and manner of installation best suited to the general and specific nature of each problem.

The importance of avoiding pitfalls, which in the past have resulted in maintenance and replacement costs beyond amounts considered reasonable, has been stressed from time to time and reported from PHA Field Offices

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and Local Authorities' maintenance departments. The following items fall in this group:

Distribution Centers - Main and feeder equipment installed in crawl spaces has been found to be affected by condensation, which causes corrosion of various parts and requires constant maintenance attention or early replacement. Crawl spaces generally are not easily accessible for normal working conditions.

Branch circuit equipment when inaccessible to tenants has placed responsibility with project management for replacement of fuse protection, with increased maintenance and operating costs.

Service disconnect equipment located where accessible to unauthorized persons has caused considerable annoyance and additional maintenance supervision.

Wiring - Improper types of wire installed in raceways which may be subject to condensation often result in a complete rewiring of a part of the system.

Excessive overloading of circuit wiring has resulted in early replacement of wiring and created a hazard to life and property.

Electric Metering - When electricity has been purchased at wholesale and check metering facilities do not permit 100 per cent metering, the arrangement has not proven satisfactory to check tenant consumption.

Protective Devices - Improper protection of wiring and equipment or none at all has been known to cause serious loss of life and property. Edison base plug fuses have been a constant annoyance, in that tenants can insert fuses of larger capacity up to 30 ampere size for 15 ampere branch circuits, or otherwise tamper with the equipment and create a hazard. The use of fuses in excess of 15 ampere capacity for a dwelling unit circuit is a definite hazard.

Outlets - The provision of outlets for ironing boards and hot plates in central and/or community laundry is an unnecessary expense, because of the custom of tenants doing laundry within dwelling units.

Base receptacles should be of the heavy duty type, as provided by the latest revision to Federal Specifications.

Laxity in providing means for grounding of future installation of automatic laundry equipment has resulted in excessive expenditure later.

Generally, special outlets for radio and television reception will not be provided in dwelling units. In special cases it may be desirable to install such outlets in rooms to be used for social and recreational purposes.

Improper location of wall switches in public spaces - where accessible to children - has been a source of annoyance and an unusual amount of replacements.

Fixtures - Bracket type fixtures with receptacle and integral control switches have not always proven satisfactory, because of the difficulty in replacement of parts.

Fixture-controlled wall or toggle switches for all locations are prescribed in the Minimum Physical Standards.

Location of basement lights where piping obstructs the illumination creates a hazard.

Lack of adequate illumination in crawl spaces, and improper control of light, has been a constant complaint.

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1. DESIGN FOR INTERIOR WIRING.

a. General. Since the choice of fuel or energy for utility services (heating, cooking, refrigeration, etc.) has considerable bearing on the electrical design, it is essential that the energy requirements be known at an early stage. The method of selecting fuels and energy for utility services is discussed in another PHA bulletin. Since electricity will always be used for lighting and miscellaneous motor driven or heating element operations, the design may be started by spotting outlets and indicating circuit wiring within dwelling units as soon as unit plans are available.

The location of lighting, convenience, and switch outlets is ordinarily a simple operation, yet because of the multiple use of dwelling unit types, more than usual care should be taken to exclude unnecessary or luxury items. (For example, on a project of 500 dwelling units, the elimination of one outlet within a unit results in a saving of 500 outlet boxes and devices and possibly 5000 feet of raceway and 11000 feet of wire.) A thorough study of the electric layout for each type of dwelling unit is necessary to achieve a desirable balance between initial cost and future operating expense.

Electrical drawings should indicate the reasonable and accurate location and sizing (where required) of all electrically operated equipment, controls and disconnects, lighting fixture outlets and switch controls, receptacles, service equipment, metering locations, branch and feeder circuit control panels, feeders and branch circuits (which should be shown connecting outlets and numbered to indicate circuit).

Details of transformer vaults, metering and distribution centers, and any special equipment, including wiring diagrams showing time controlled circuits, should be prepared.

After the branch circuiting design and the point(s) of branch circuit distribution have been determined, riser diagrams, general feeder layouts and electrical drawings generally can be completed.

To accommodate the building master disconnect, meter center and/or distribution center, inside a building where there is no basement, the floorplan must provide space for the required equipment. Where this equipment is required to be on the exterior of a building, a location that will permit at least partial concealment by planting or other means will prevent marring the exterior appearance of buildings.

Incorporate not less than the minimum requirements of governing rules and regulations, as prescribed by:

National Electrical Code (latest edition)
Local Municipal and/or State codes and regulations
Local utility company's regulations
Any other governing bodies

except that any requirements which appear to be unnecessarily restrictive should be reviewed with the proper authorities in an effort to secure modifications and waivers.

Work shown on drawings contrary to rules and regulations, and not covered by waivers, requires changes during construction and involves unnecessary expense.

For uniformity in use of electrical wiring symbols, select from the standards of the American Standards Association those applicable to the requirements of the project (as illustrated in Figure 1).

b. Distribution Centers. Distribution centers may be divided into three groups: branch circuit, feeder, and main. Under all conditions, provision should be made for branch circuit centers, while feeder and main centers will be installed only if the design requires them.

The location of distribution centers depends on the type of building, meter locations, and electrical equipment served. In determining the method of distribution and type(s) of distribution, design a system which will reflect the lowest practical "economic cost", that is, the lowest initial cost, consistent with low maintenance and operating expense.

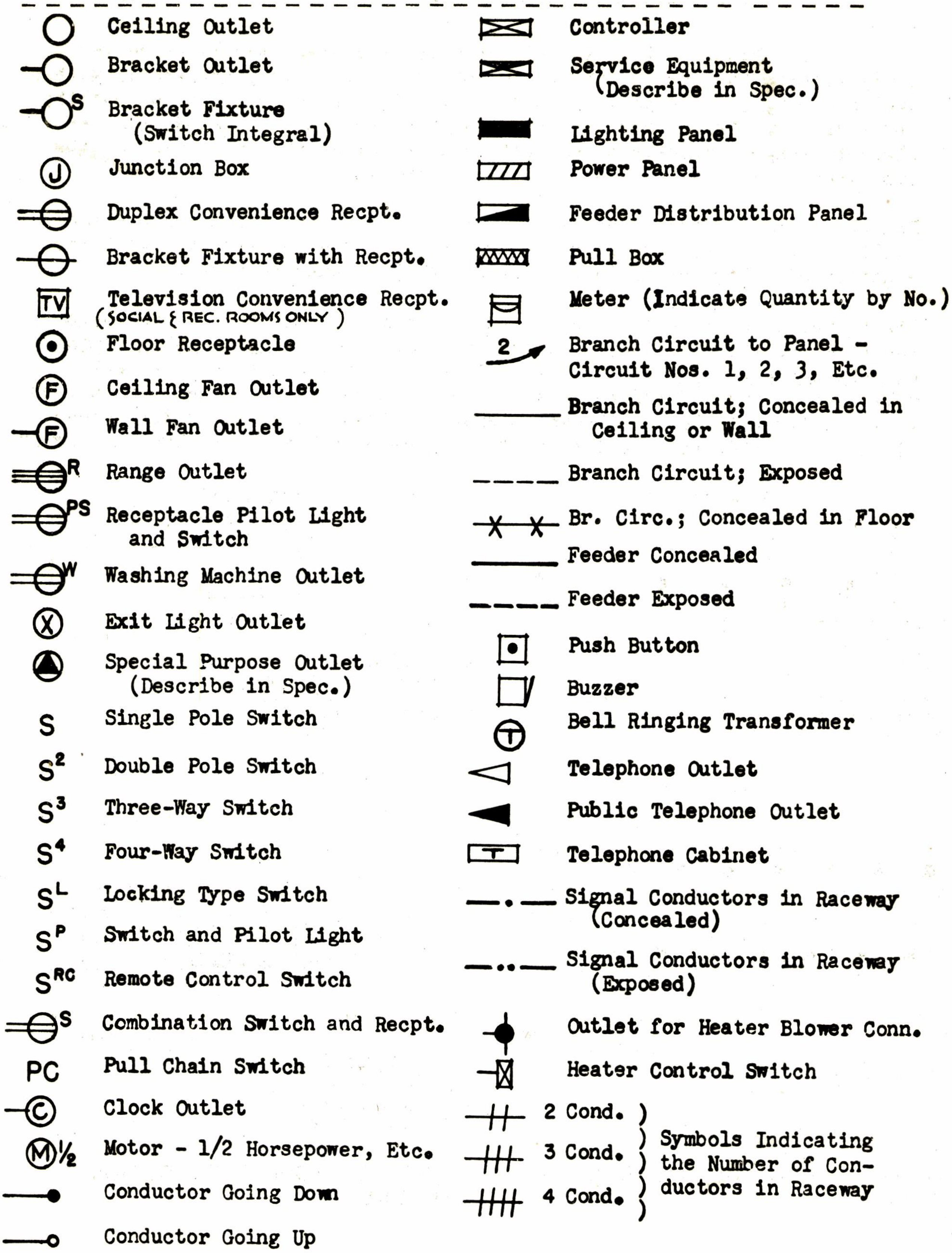

FIGURE I ELECTRICAL SYMBOLS

(1) Branch Circuits. Branch circuit centers should be conveniently located for the restoration of circuit protection, preferably within dwelling units, especially if electric cooking is included in the utility services. Electrical appliances rated at more than 1650 watts, such as electric ranges, require disconnecting means other than as a part of the appliance, and readily accessible to the operator.

Branch circuit centers usually consist of two or three lighting and small appliance circuits, depending on the size of the dwelling unit, with the addition of a high capacity circuit for cooking when required.

The branch circuit center under certain conditions may include the meter socket in addition to the panel proper. Back-to-back combination branch circuit centers and metering are available for installation in exterior wall construction of thicknesses varying from 4½" to 7". The meter socket faces on the exterior of the wall, with the branch circuit center accessible from inside the dwelling units. By decentralizing the branch circuit

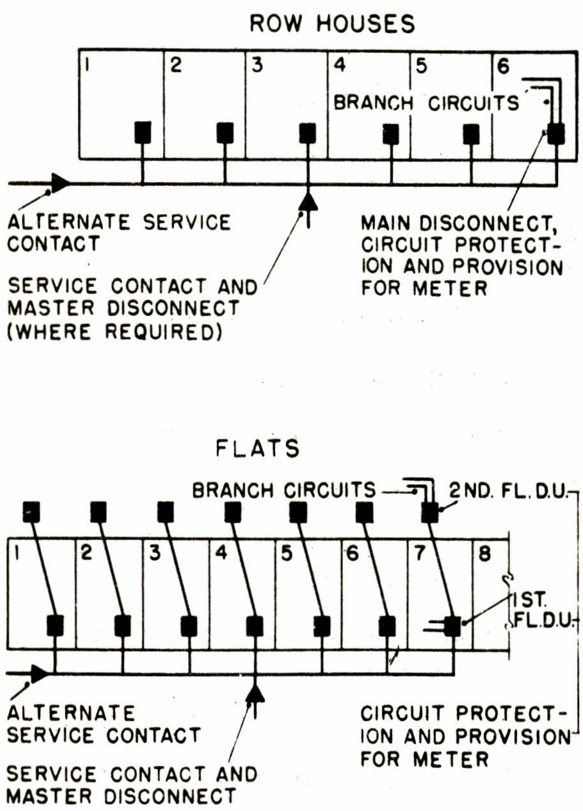

FIGURE 2 INDIVIDUAL DISTRIBUTION CENTERS

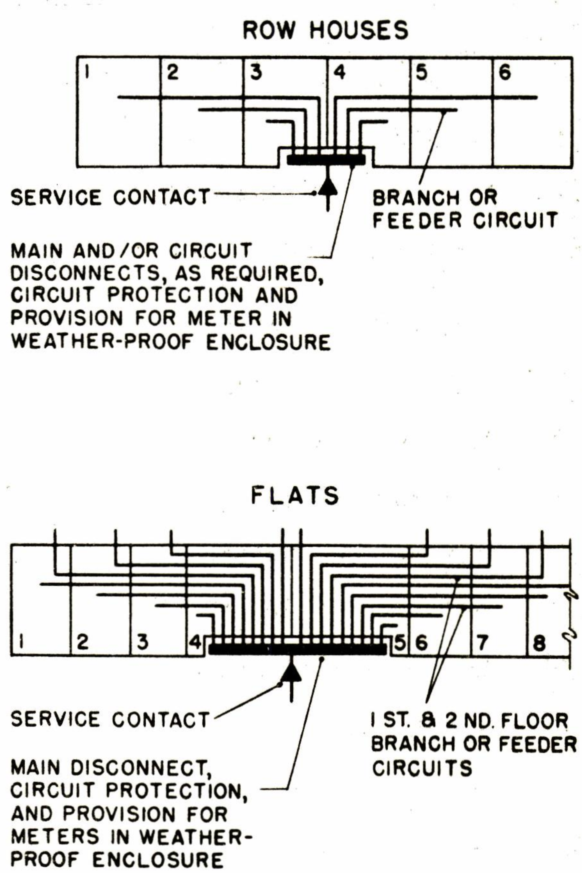

FIGURE 3 GROUP DISTRIBUTION CENTERS

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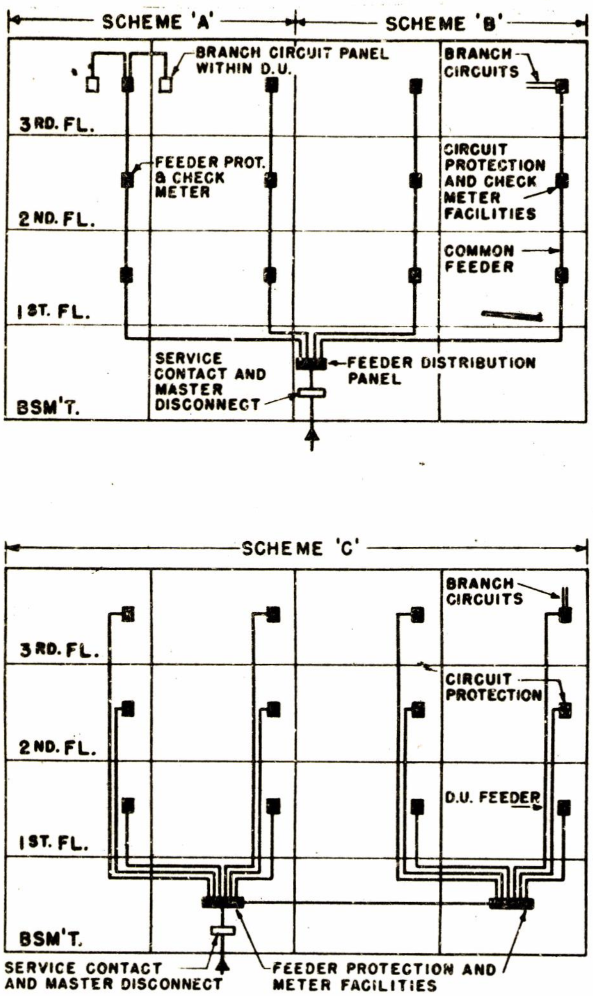


NOTE SCHEME 'C':
CONDUCTORS OF A 3 PHASE, 4 WIRE SYSTEM MAY BE GROUPED IN ONE CONDUIT, WITH A SINGLE PHASE SERVICE CONNECTION TO EACH OF 3 LOAD CENTERS.

GENERAL NOTE:
WHERE PRACTICABLE, BRANCH CIRCUIT AND/OR FEEDER PROTECTION AND METER FACILITIES MAY BE LOCATED IN PUBLIC HALLWAYS AND GROUPED ON EACH FLOOR, OR ON INTERMEDIATE FLOOR SERVING THREE FLOORS.

FIGURE 4 FEEDER DISTRIBUTION FOR APARTMENTS. INDIVIDUAL (ABOVE) — GROUP (BELOW)

protective outlets, the tenant has access to the branch circuit center and responsibility for restoration of branch circuit protection, thereby reducing operating maintenance cost, with use of standard equipment.

Under certain conditions of operation project management may desire centralization of all branch circuit centers being used as distribution centers. The centers in such case should be located near the longitudinal center of row house buildings or near the center of load in apartment type buildings, to avoid undue lengths of branch circuits and corresponding increase in copper sizes. This arrangement places full restoration of branch circuit protection with operating maintenance greater than where decentralized branch circuit centers have been installed. Equipment for centralization requires special panel connections. (For illustration see Figures 2 and 3.)

(2) __Feeder__ - A feeder distribution center, or several centers from which feeders extend to branch circuit centers, are usually required in apartment type buildings. This arrangement may also be necessary for certain types of row houses and two-story buildings with flats. Where electric energy is purchased wholesale, PHA standards require that the design provide for future installation of 100 per cent check-metering to permit control of consumption. For row house buildings, the location of individual dwelling unit check-meters will be governed by the design and location of branch circuit protection.

Feeder distribution centers should not be located within crawl spaces or in a dwelling unit.

(For typical illustrations of feeder center locations see Figures 2, 3 and 4.)

(3) Service Disconnect - Locate service disconnect within the building to be served and adjacent to branch circuit or a part of the feeder distribution center. The disconnect should be readily accessible to maintenance operator and beyond reach of children. Under certain conditions in row house buildings, the disconnect will be located on the exterior of buildings, with the handle about five to six feet above grade.

c. Wiring. Interior wiring should be designed on the basis of a voltage drop not to exceed 3 per cent from point of building service connection to the last outlet with all lamps and devices in operation and loadings based on 75 per cent of code recommended allowances. (Article 220 - 1947 N.E. Code). (Figures 5 and 6 illustrate branch circuit wiring details within dwelling units.)

In general, in fireproof buildings, metal raceways with insulated wires are used.

In non-fireproof structures, armored cable, non-metallic cable or knob and tube wiring may be used, subject to the requirements of all governing bodies having jurisdiction.

Conductors in raceways should be lead covered, moisture resistant rubber covered or other type especially approved for use where raceways are installed: (1) underground, (2) in concrete slabs or other masonry in direct contact with earth, (3) in wet locations, and (4) where condensation within raceways is likely to occur.

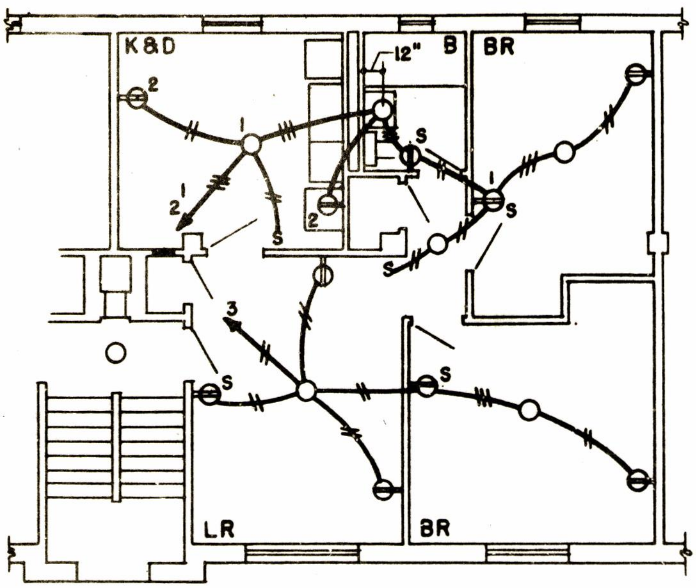
Service entrance conductors shall not be run through hollow spaces of, or within, frame buildings for a distance greater than five feet, unless provided with overcurrent protection at their outer end.

d. Signalling and Communication. The various facilities for signalling and communication may be divided into the following groups: call system, alarm system, telephone system, radio system, and television system.

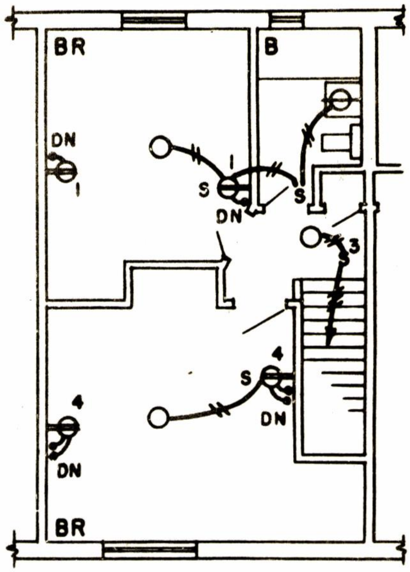
In considering the needs of low-income tenants initial cost, maintenance and operation, and the necessity for protection of safety, health and decency of living become an important factor for overall planning.

(1) Call System - Where means for calling are necessary, a mechanical device mounted directly on the dwelling unit entrance door may be used (rather than an electric calling system which is more expensive to install and maintain).

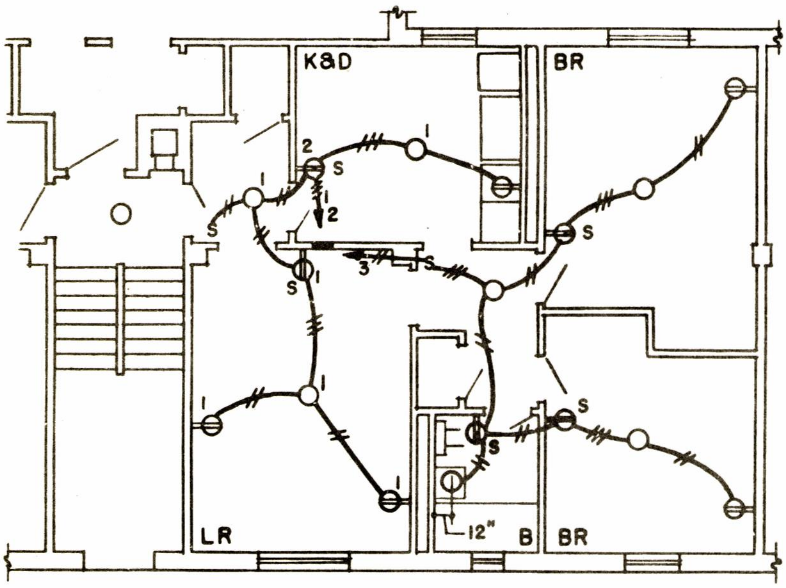
Automatic door openers are impractical, unless a means of communication is installed to control its use. Since this type of equipment is unnecessarily expensive for low-rent housing, its use is not appropriate.



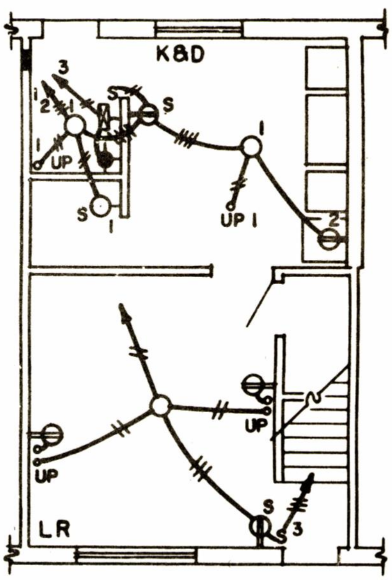
RIBBON TYPE 2-BEDROOM APARTMENT



SECOND FLOOR PLAN



TEE TYPE 2-BEDROOM APARTMENT



FIRST FLOOR PLAN

NOTE
1. KITCHEN CEILING FIXTURE IS LOCATED 1/3 OF DISTANCE FROM CABINETS TO OPPOSITE WALL.
2. COMBINATION SWITCH AND RECEPTACLE UNITS ARE LOCATED 6" BEYOND EDGE OF OPENED DOOR WHEN THESE UNITS ARE LOCATED ON WALL ADJACENT TO DOOR HINGE.
3. DO NOT LOCATE CONDUITS, OUTLETS, ETC. AT END OF BATH TUB.
4. ROUTING OF HOME RUNS IS DETERMINED BY LOCATION OF PROTECTIVE CABINET.

THESE PLANS NOT TO BE USED FOR DWELLING DESIGN PURPOSES.

FIGURE 5 WIRING PLAN FOR APARTMENTS AND FLATS

FIGURE 6 WIRING PLAN FOR TWO STORY ROW HOUSE

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(2) Alarm System - In general, fire alarm stations and gongs are unnecessary for row houses and flats (of the walk-up type). In apartment buildings (with elevators), consult the local governing board having jurisdiction, and where such regulations appear unnecessarily restrictive, endeavor to secure waivers.

(3) Telephone System - The desirability of planning for future telephone installation in the individual dwelling units is generally recognized. This should consist of minimum adequate roughing-in to permit, at a later date, the introduction of cables, cable terminals, protectors and wires with minimum cutting of structures.

Experience of existing projects indicate that the demand for service varies from two per cent to 55 per cent of the number of dwelling units in a project.

Consult with the local telephone company regarding requirements for their facilities and experience in providing the most economical layout. The service of their engineers is usually available without cost, for consultation and advice on all matters pertaining to telephone systems for low-rent housing projects.

In general, the following provisions for the future installation of telephone service are considered adequate for low-rent housing projects:

Row Houses and Flats Without Basement or Crawl Spaces 1/

Service sleeve, with closed bushings, through exterior wall for each dwelling unit.

Row Houses With Basement or Crawl Spaces

Sleeve through a closet floor (if of concrete) in each dwelling unit.
Service sleeve or sleeves through exterior wall.

Flats and Apartment Type Buildings (Walk-Up) With Basement or Crawl Spaces

First floor dwelling units - sleeve through a closet (if of concrete) in each dwelling unit.

For each dwelling unit above first floor - a vertical raceway extending to the basement or crawl space.

Service sleeve or sleeves through exterior wall.

1/ For service to each building, telephone company engineers must be consulted, regardless of detail and location of sleeves through exterior walls.

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Flats and Apartments Type Buildings (Elevator)

Vertical raceway near center of building and branch raceway to dwelling units.

For buildings with six or less dwelling units, without basement and with crawl space headroom of less than 3'-6", telephone protective equipment may be mounted on the exterior of the building. Buildings with more than six dwelling units and without basement or adequate crawl space will require a closet (30" high, 20" wide and 10" deep) accessible from the exterior of the building, for housing the individual protectors or "L" type cable terminal, as may be required. The provision of such a closet would preserve the appearance of the building. For apartment type buildings (with elevator) provide space on each floor, or alternate floors, near the center of building for telephone terminal connection equipment as prescribed by the local telephone company.

(4) Radio System - Do not provide any raceway in the building structure for radio reception facilities, since present radio receiving equipment is provided with built-in antenna satisfactory for normal reception.

(5) Television System - Television is a comparative newcomer in the field of radio. An antenna system for television (TV) receiving is not unlike an antenna system for amplitude modulation (AM), or frequency modulation (FM) radio receiving.

IN MOST LOCALITIES, INDOOR OR BUILT-IN ANTENNA SYSTEM WILL PROVIDE AMPLE SIGNAL STRENGTH FOR RECEPTION, THEREFORE, THE NEED FOR AN OUTDOOR ANTENNA SYSTEM WITH THE REQUIRED ADDITIONAL EQUIPMENT IS DEEMED UNNECESSARY AND UNDESIRABLE.

e. Options. Options should be allowed the contractor only when the Local Authority is unable to choose between systems or equipments which meet the requirements. When options are permitted, it is essential to specify equipments which are equivalent in function and amount of labor and supplementary equipment required for operation.

f. Approval. In localities where required, layouts should be approved by the governing body, before issuance of documents for bidding purpose.

2. DESIGN FOR ELECTRIC METERS.

a. General. Meters should be installed only after operating experience on the project has indicated the necessity for them. When it is determined that a check on current consumption is required, the installation of 100-per cent meters is advisable, since metering only part of the tenants at a time has not proven satisfactory.

When adequate energy and fuel for all utility functions, lighting, refrigeration, cooking, domestic hot water and space heating are furnished by the project and included in the tenant's lease, check-meters are not likely to be needed. On the other hand, when any one of the functions is omitted as a service provided by the project, a diversion of energy may occur, by the tenant attempting to use project-furnished fuel or energy for a function which he is supposed to furnish.

The encouragement of thrift in the use of electric energy is of considerable importance where tenants of low income are housed. The electric energy allowance to be included in the tenant's lease is considered sufficient for minimum requirement of safety, health and decency.

It is desirable that meter location be convenient to permit meter reading by the tenant, since it enables him to check his consumption against the amount allotted and included in his lease.

Where project service is centralized, as in heating plants or where it may be difficult for the management to estimate energy consumption, facilities for metering the electric energy for the project service portion is very desirable.

Metering equipment and meters, when installed, should be locked in place by means of seals secured with a project stenciled clamping device.

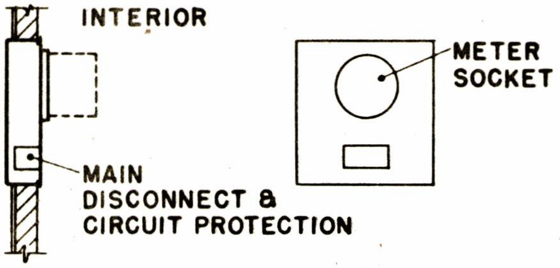
b. Arrangement. Metering facilities required for future installation of tenant check-metering may be in the form of (1) space only for the meter with means for inserting meter tap in circuit or (2) socket or receptacles to receive detachable type meters. (See Figure 7 for typical arrangements.)

c. Locations. The advantages and disadvantages of placing meters "inside" or "outside" of dwelling units may be outlined as follows: 1/

Inside of Dwelling Units

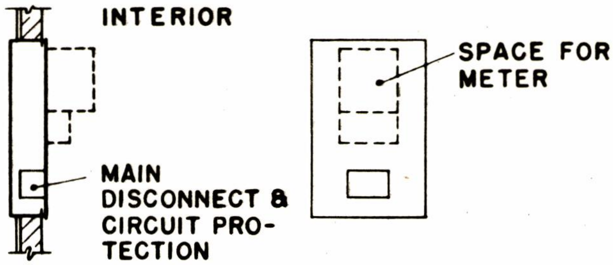
Advantages	Disadvantages
The meter is prominently in view of tenant	Requires management to gain admittance to dwelling units at periodic

1/ In flats and apartment type buildings of three or more stories in height, where it is necessary to provide feeder distribution centers and individual branch circuit centers, meters located at distribution centers would not increase the cost, and meter-reading cost will result in minimum operating expense.



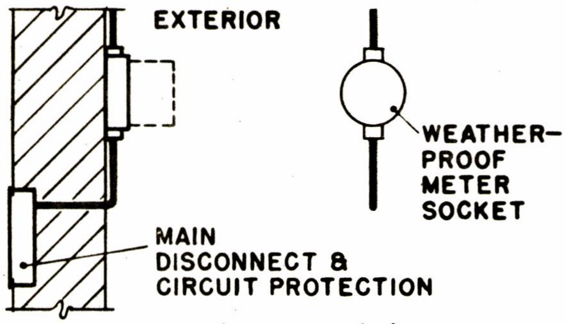
SCHEME -'A'

USING DETACHABLE TYPE METER SOCKET SET FLUSH IN TRIM OF CABINET



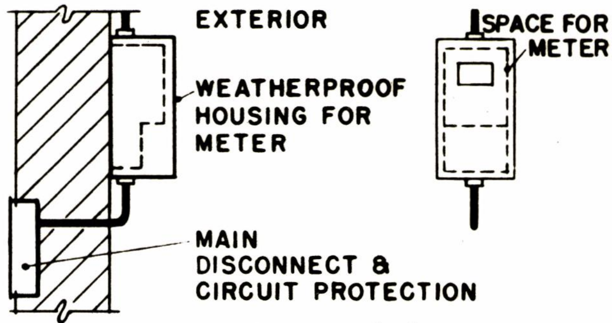
SCHEME -'B'

PROVIDING SPACE ON TRIM OF CABINET FOR SURFACE MOUNTING TYPE METER



SCHEME -'C'

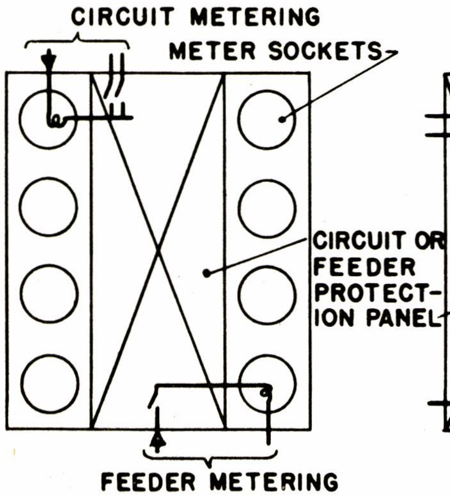
USING DETACHABLE TYPE METER SOCKET, SURFACE MOUNTED



SCHEME -'D'

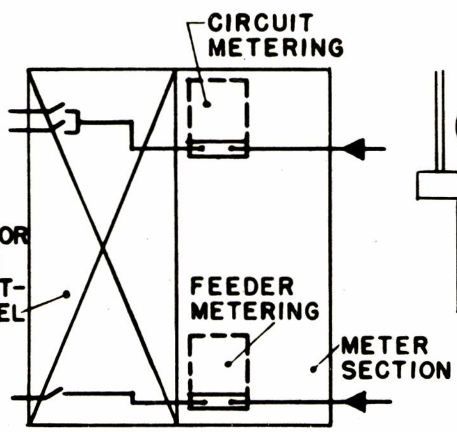
PROVIDING WEATHERPROOF CABINET FOR SURFACE MOUNTING TYPE METER

INDIVIDUAL INSTALLATION



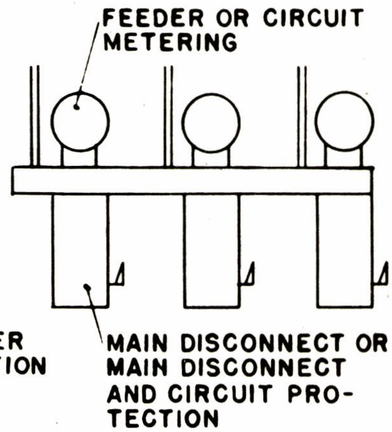
SCHEME - I'A'

USING DETACHABLE TYPE METER SOCKETS SET FLUSH IN TRIM OF CABINET



SCHEME - I'B'

USING TYPE 'A' METER FOR MOUNTING IN CABINET WITH TERMINAL BLOCK



SCHEME - I'C'

USING WIRING TROUGH

GROUP INSTALLATION

FIGURE 7 PROVISION FOR DWELLING UNIT METERING

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Advantages (Cont'd)

Non-weather proof equipment may be used.

Simplified wiring, direct mounting on branch circuit panel.

Management collection of excess use charge is simplified by reading meter in presence of tenant, thus avoiding dispute about excess use.

Disadvantages (Cont'd)

intervals, perhaps four times annually; incurring additional operating expense. Since a given day usually will be designated, some difficulty may be encountered in gaining entrance for meter reading.

Management staff members may be required to listen to tenants' complaints which are the problem of others in the project office staff, which will delay reading of meters within a definite allocated time, with increase in operating cost.

Outside of Dwelling Units

Advantages

Accessible to management and to tenant, thereby eliminating need for return calls and resulting in reduced meter reading expense.

Disadvantages

Not prominently in view of tenants.

Weatherproof equipment needed.

d. Types. Meters located within or immediately outside of dwelling unit, if provided with the cyclometer dial, may be read by tenant and management, thus precluding the necessity for instructing the tenants by operating personnel. Meters located elsewhere, under direct control of the management, may be of the standard or cyclometer dial type.

Where practical and load permitting, provide 2-wire service to dwelling units so that 2-wire meters may be used. On a 3-phase, 4-wire secondary system, a 3-wire 120/208 volt service to a dwelling unit panel or branch circuit center will necessitate the use of a two element meter, the cost of which is approximately 100 per cent greater than the 2-wire meter.

3. DESIGN FOR PROTECTIVE DEVICES.

a. Overcurrent protection for dwelling unit circuits should be provided by circuit breakers or plug fuses of the non-tamperable type with screw base adapters (a PHA Minimum Physical Standards requirement). Carefully choose the type of device which is most suitable on the basis of (1) initial cost, (2) comparative cost of maintenance, repair and replacement; and (3) operating conditions peculiar to the locality.

Where fuses are to be used, provide non-tamperable plug fuses of a type which will prevent (1) the insertion of fuses of greater capacity than the rating of the adapter, and (2) the insertion of coins or other metal between the blown fuse and base of socket. This type of fuse is known as "type S" and requires the installation of a screw base adapter in the standard "Edison base" socket. The initial cost is slightly higher than the standard plug fuse; but better protection is afforded the circuit wiring, and maintenance costs reduced.

With branch circuit centers located within dwelling units replacement of fuses will be a tenant responsibility. In some localities where local stores do not carry adequate stock of fuses, the management may find it necessary to maintain a supply for resale to the tenants or arrange with local stores to supply the tenants' needs.

b. The protective devices in the main service feeder distribution center and branch circuit panel installation are to be planned so that an overload on one or more of the dwelling unit circuits will not cause the protective devices ahead of the branch circuits to operate before the branch circuit devices open, resulting in a complete shut-down to the particular dwelling unit group.

c. Where thermal circuit breaker protection is to be used for branch circuits, it is important to provide proper time lag protective devices ahead of the branch circuits.

The most satisfactory division of circuit protection appears to be:

(1) General purpose circuits (15 amp.) to serve fixed lighting outlets throughout the unit. Provide one circuit for each 500 sq. ft. of floor area or fraction thereof.

(2) Appliance circuits (20 amp.) to serve receptacle outlets only in kitchen, dining space, and utility room.

(3) Furnace heating equipment (15 amp.) circuits to serve individual tenant heating plant electrical equipment; install protective device at equipment as required.

(4) Cooking range and/or water heater circuits shall not be provided unless they are justified by the utility analysis.

4. DESIGN FOR ELECTRICAL OUTLETS.

a. General. The recommended minimum requirements of the National Electrical Code regarding number of convenience outlets per room have been adopted as minimum standards for PHA-aided low-rent housing projects. Included below in this section are recommended practices regarding installation of electrical outlets.

Avoid an <u>excessive</u> number of convenience outlets. Adequate outlets, however, as may be required by the plan layout, should be provided to discourage an excessive -- and often dangerous -- use of exposed extension wires by tenants.

Avoid running branch circuits of one dwelling unit through outlets of other dwelling units.

Do not locate outlets, conduits, etc., in partition at end of bath tub; they interfere with repair and replacement.

In stairhall locate three-way switch at top of stairs not less than two feet from the top step to minimize the falling hazard when groping in the dark.

So far as practical, avoid the installation of outlet boxes in exterior walls wherever a vapor barrier is to be installed; where outlets must be so placed, detail the work so that the vapor seal is unbroken at these points.

In crawl spaces provide a receptacle, switch and lighting fixture outlet near entrance and additional receptacle and lighting fixture outlets to permit use of 100 ft. extension cord for a small degree of illumination in the crawl space area.

Install devices located on opposite faces of the same wall back to back, where practical.

The convenience receptacle for refrigerator connection should be placed at such height and location as to also serve the work table, when the kitchen layout will permit.

Arrangement of outlets for a typical dwelling unit is illustrated in Figures 5 and 6, "Design for Interior Wiring."

b. <u>Lighting Outlets</u>. Locate ceiling and wall lighting fixture outlets to provide efficient distribution and illumination. Locate ceiling lighting outlet in kitchen off-center (12 inches from edge of apron of sink and on center line of sink) to provide a higher degree of illumination at sink and work surfaces. Bathrooms may be provided with either ceiling or bracket fixtures; center the ceiling lighting fixture outlet over lavatory 12 inches from wall; center the wall bracket lighting outlet above medicine cabinet with ample clearance between fixture and medicine cabinet door. Ceiling outlet in living room and bedrooms is considered more satisfactory than wall bracket outlet for general distribution of illumination.

c. <u>Switch Outlets</u>. Wall switch outlets are to be provided for control of ceiling fixtures.

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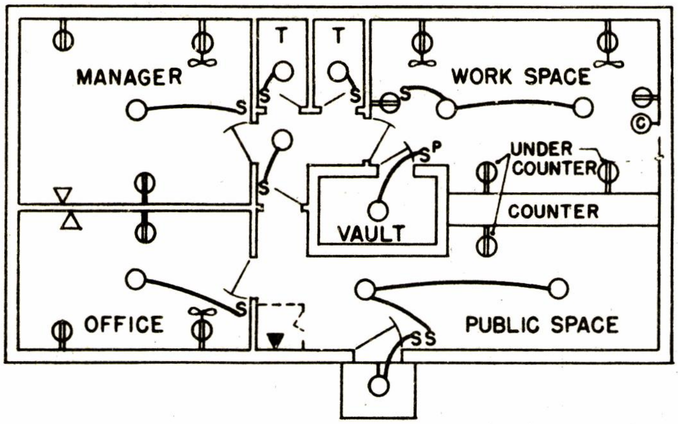
d. Receptacle Outlets. Wherever feasible, combine receptacle and switch in one outlet box.

e. For Management, Social and Recreational Spaces the diagrams Figures 8, 9, 10 show average conditions, since arrangement of spaces will vary with specific requirements. Infrequently additional outlets may be justified to achieve greater efficiency.

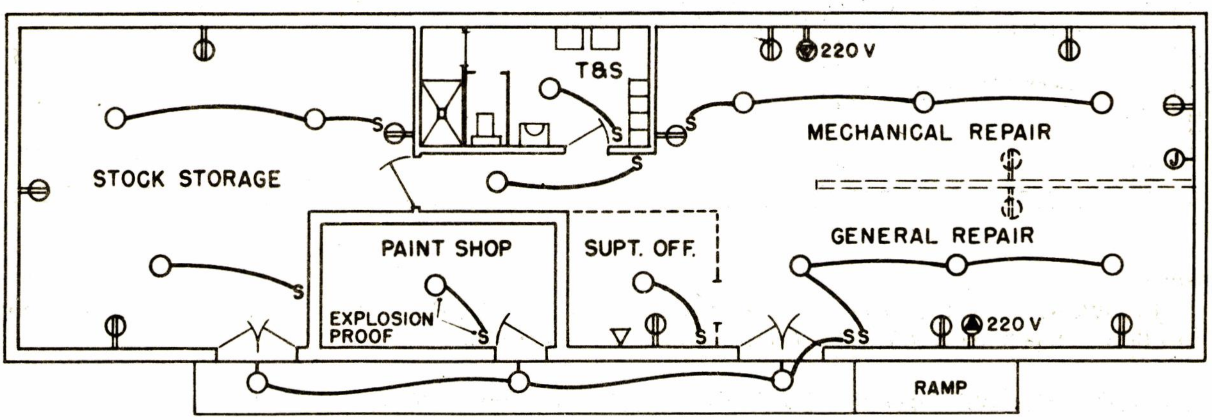


THIS LAYOUT IS TO INDICATE THE ARRANGEMENT OF ELECTRICAL WORK ONLY FOR THE VARIOUS SPACES. THIS PLAN IS NOT FOR BUILDING DESIGN PURPOSES.

FIGURE 8 WIRING PLAN FOR MANAGEMENT SPACES

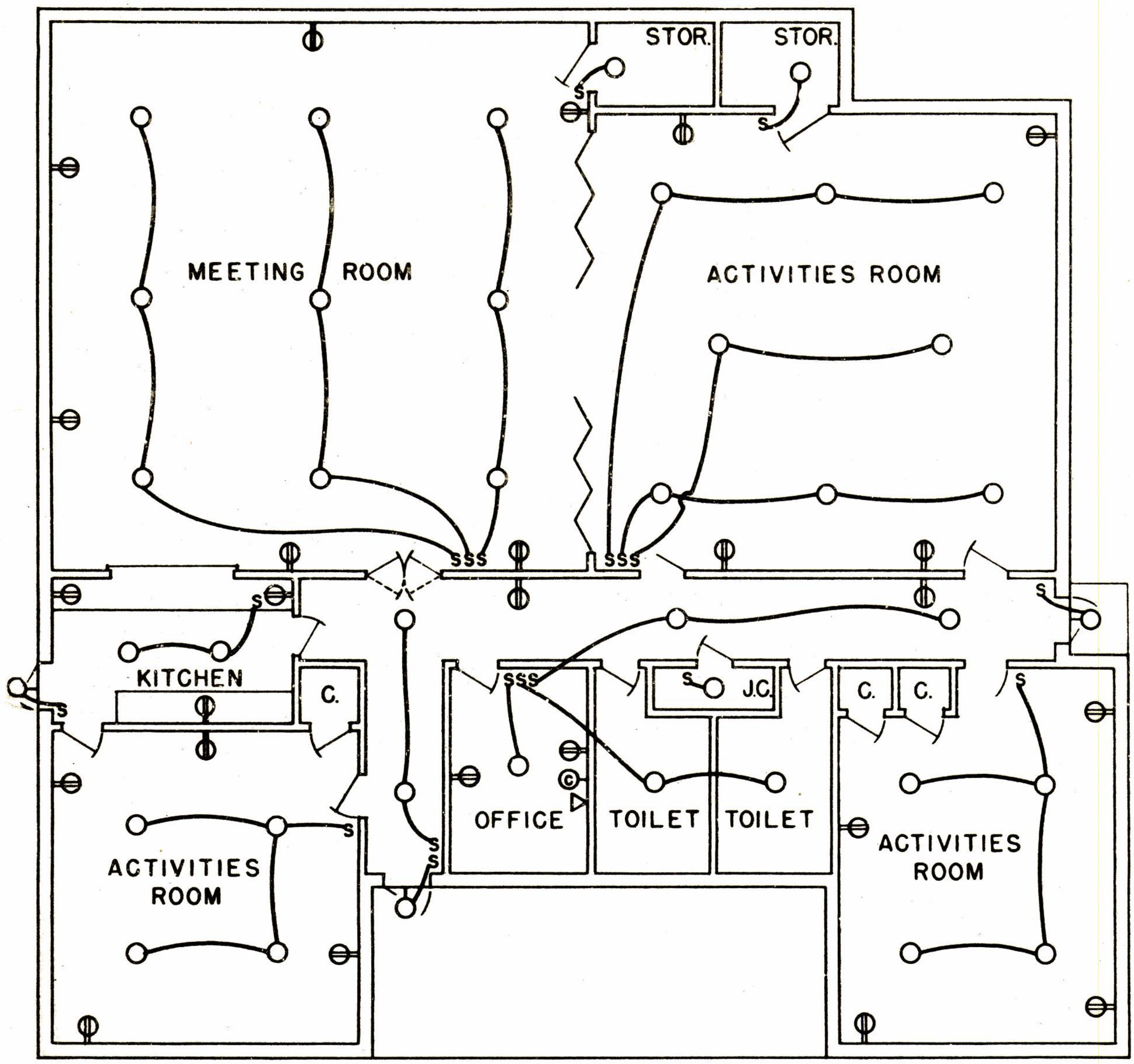
f. Community Laundries. When project community laundries are planned, provide outlets for (1) non-automatic and automatic washing machines, (2) mechanical drying units, (3) ventilating fans, and (4) artificial illumination.

Requirements covering the number of washing machines and mechanical driers which will suitably service a project are outlined in a forthcoming Bulletin on group laundries and their operation.



THIS LAYOUT IS TO INDICATE THE ARRANGEMENT OF ELECTRICAL WORK ONLY FOR THE VARIOUS SPACES. THIS PLAN IS NOT FOR BUILDING DESIGN PURPOSES.
USE NOT LESS THAN NO.12 WIRE SIZE THRUOUT MAINTENANCE BUILDING.

FIGURE 9 WIRING PLAN FOR MAINTENANCE AND WORK SPACES



NOTE:
THIS LAYOUT IS TO INDICATE THE ARRANGEMENT OF ELECTRICAL WORK ONLY FOR THE VARIOUS SPACES. THIS PLAN IS NOT FOR BUILDING DESIGN PURPOSES.

FIGURE 10 WIRING PLAN FOR RECREATION SPACE

These are based upon operation under the supervision of management, tenant groups or distributor. It is important that the Local Authority decide the method of operation at an early date to assist the designing engineer in arranging equipment and the means for proper services. The following are types of equipment indicating the outlet requirements:

(1) Non-automatic washing machines will require a drop cord type receptacle outlet at the double laundry tray.

(2) Automatic washing and drying machines will require a receptacle outlet on the wall approximately 4 feet above finished floor.

(3) Ventilating fans will require an outlet for connecting service to fan motor (where cross ventilation is inadequate).

(4) Means for grounding the equipment should be provided, regardless of the type of equipment which may be installed at a later date, to avoid unnecessary expense.

A survey of a number of low-rent housing projects where ironing boards and hot-plate units had been installed indicates that their removal was recommended because:

(a) Ironing in general is performed in dwelling units. Therefore provision should <u>not</u> be made in community laundry spaces for ironing.

(b) Hot plate units are a source of unusual high maintenance; unsightly when improperly maintained; source of hazard by accidental burning. Outlets for hot plate units are not recommended.

Outlets for illumination should be so placed that the distribution of light will fall directly on trays, work tables, and other pieces of equipment.

As supervision of laundry spaces is desirable, provision should be made to control the lighting and electrical equipment of laundry spaces, excluding ventilating fan, by means of a time-clock control device.

5. DESIGN FOR LIGHTING FIXTURES.

a. General. In the selection of lighting fixtures for dwelling units, consideration should be given to the difficulties which have been encountered in management operations. Low initial cost with low maintenance and repair expense are factors in deciding the best and most suitable types of lighting fixtures. 1/

1/ It will be noted that in the illustrations of lighting fixtures, Figure 11, and in the general discussion of lighting fixtures for dwelling units no mention is made of fluorescent or other newer types of lighting fixtures. Such new developments are not prohibited under PHA standards, nor does the PHA wish to imply that it does not favor any advance in illuminating methods. However, based upon experience, not only in initial but in operating costs, it appears that the type of illumination recommended herein for dwelling units is well adapted to low-rent housing.

Since many tenants will not own portable lighting fixtures, it is important that every room in the dwelling be equipped with a fixture.

Include on electric drawings or in the Specification a schedule of the fixtures required for the various locations, with references to (1) detailed sketches or (2) trade names and catalog numbers, prefixed by the phrase, "similar in design and equal in quality."

b. Control. The PHA Physical Minimum Standards require the control of all fixtures by means of wall type switches or toggle switches mounted integral with equipment.

c. Intensity of Illumination. Recommended artificial illumination in the dwellings is an average of five foot-candles, measured in a horizontal plane 30 inches above the floor area in each occupied room (utility rooms excepted) with twenty (20) foot-candles normally allowed at points where reading is done and specific tasks are performed; on stairs and in passageways, three (3) foot-candles are adequate. In public vestibules, halls, and stairways, provide approximately 1/2 watt per square foot of floor space.

The following lamp sizes for dwelling spaces, and type of control are recommended:

(1) Living Room - 100 watt - wall switch
(2) Bedroom - 60 watt - wall switch
(3) Kitchen - 100 watt - wall switch
(4) Bathroom - 40 watt - wall switch
(5) Halls - 40 watt - wall, or fixture toggle switch
(6) Utility Room - 25 watt - wall, or fixture toggle switch

Exterior front and rear entrance lights under the control of tenants are not considered necessary for row houses, where yard lighting provides sufficient illumination of entrances and porches. However, when conditions warrant their installation, they should be located above, or at side of entrance door to properly illuminate the features of persons calling at the dwelling unit.

d. Types.

(1) Dwelling Spaces. Suggested types of lighting fixtures which are considered suitable are illustrated in Figure 11. These will meet the requirement for low maintenance and repairs and are of simple and sturdy design, with durable finish, interchangeable parts, and provide maximum efficiency of illumination.

(2) Public Spaces. Beam type ceiling fixtures are considered satisfactory for hallways and stairways. Public vestibules and entrances, however, may require some other type of fixture to suit the architectural

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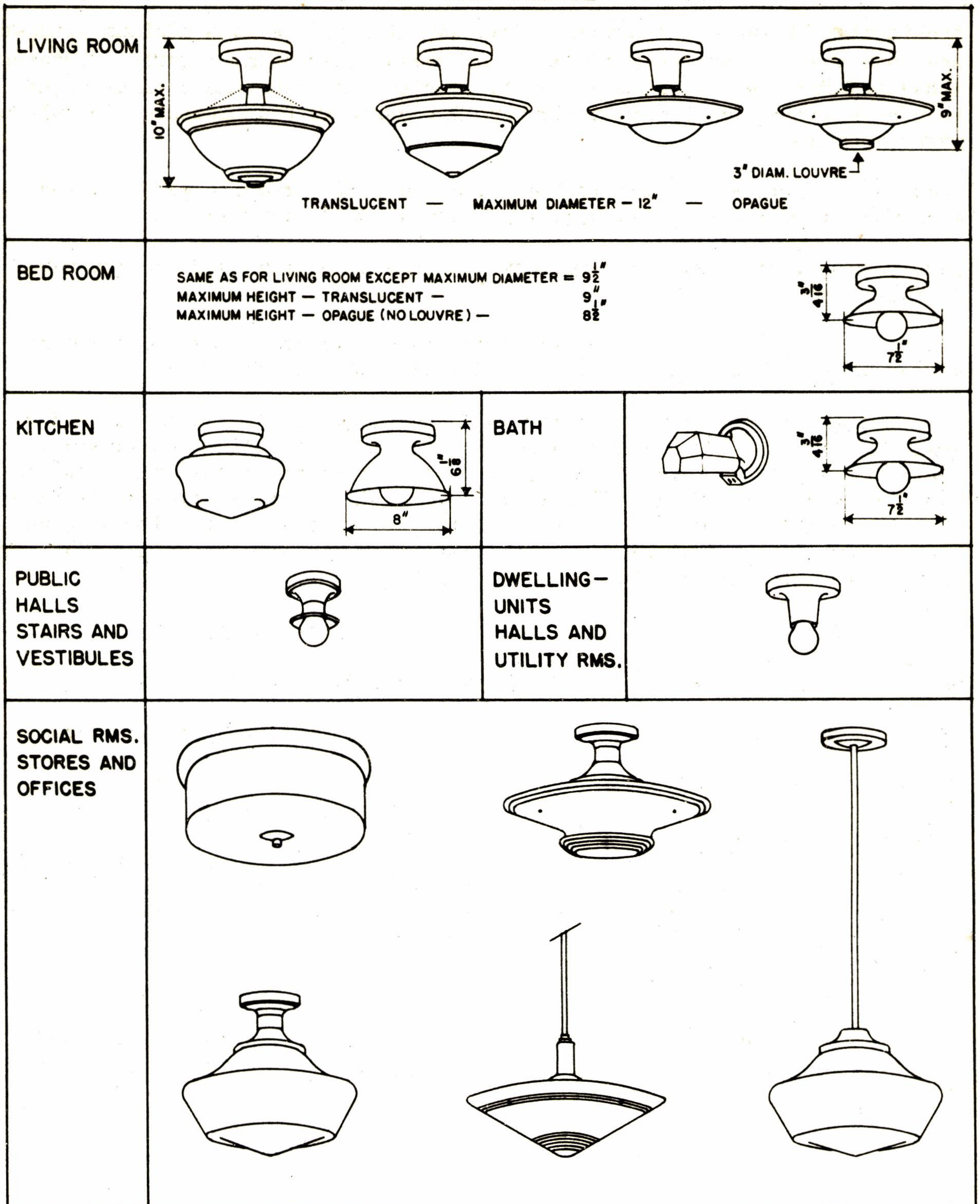

THE DESIGNS INDICATED ABOVE ARE GIVEN ONLY TO CONVEY THE DESIRE FOR SIMPLICITY, FIXTURES SIMILAR IN DESIGN SHOULD BE CONSIDERED.

FIGURE NO.11 — LIGHTING FIXTURES

treatment. Fixtures, if properly located, will reduce to a minimum shadows and dark areas. For convenience of management operation, lighting fixtures scheduled for use only from sunset to sunrise, or from sunset to midnight, should be automatically controlled by time switches (supplemented by relays where necessary).

Community space, management offices, and shops will require well lighted areas commensurate with the type of functions to be carried on.

For meeting rooms used for gymnasium purposes it is advisable to provide fixtures with wire guards.

Locations subject to moisture, explosive vapors or other special conditions and exterior basement entrances, require special type fixtures.

In recommending the types of fixtures illustrated, it is not the intent to exclude the use of fluorescent lamp type fixtures in public spaces where their use may be considered warranted. It is recognized that intensity of illumination of a 100 watt fluorescent lamp bulb is higher than a 100 watt incandescent lamp bulb. In selecting the type of fixture for these spaces, the following advantages and disadvantages of fluorescent lighting fixtures should be considered carefully.

Advantages	Disadvantages
More pleasing in appearance	Higher initial cost
Longer lamp life	Higher operating cost due to more equipment to maintain
Higher intensity watt/sq. ft.	Stroboscopic effect
More uniform illumination	Extra care in disposing of worn-out bulbs, because of the inside coating materials being of poisonous substances.
Adaptable to harmonious architectural treatment	Greater radio interference
Lower heat	

(3) Crawl Spaces. Provide a (non-metallic type fixture mounted on an outlet box, and with an integral receptacle for the insertion of an extension cord for a portable lamp.

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ELECTRICAL

PART I - INTERIOR INSTALLATIONS

1. INTRODUCTION. Interior electric light and power for PHA-aided low-rent housing projects differs very little in basic details from minimum requirements established for average private housing developments.

The essential needs should be geared to simplicity in design, a special need for economy, safety, efficiency of operation, and customary convenience rather than to luxury use. Nothing that will result in unnecessary expense (initial or operating) should be included, but nothing that is essential to satisfactory long-range use should be omitted. Engineers should have an understanding of the problems inherent in low-rent housing, which often require more than average skill and ingenuity.

Designs based on the minimum requirements of the National Electrical Code will meet the fundamental objectives for safety and utilization; essentially it is a safe code, and installations made in accordance with its requirements as they pertain to the various functions will be safe when properly maintained and not abused. This does not preclude compliance with requirements of the local municipal, State regulatory board, or local utility when such requirements are mandatory within a locality.

2. PLANNING CONSIDERATIONS

a. General. Since the choice of fuel or energy for utility services (heating, cooking, refrigeration, etc.) has considerable bearing on the electrical design, it is essential that the energy requirements be known at an early stage. The method of selecting fuels and energy for utility services is discussed in PHA Bulletin LR-11. Since electricity will always be used for lighting and miscellaneous motor driven or heating element operations, the design may be started by spotting outlets and indicating circuit wiring within dwelling units as soon as unit plans are available.

The location of lighting, convenience, and switch outlets is ordinarily a simple operation, yet because of the multiple use of dwelling unit types more than usual care should be taken to exclude unnecessary or luxury items. (For example, on a project of 500 dwelling units the elimination of one outlet within a unit results in a saving of 500 outlet boxes and devices and possibly 5000 feet of raceway and 11,000 feet of wire.) A thorough study of the electric layout for each type of dwelling unit is necessary to achieve a desirable balance between initial cost and future operating expense.

Electrical drawings should indicate the reasonable and accurate location and sizing (where required) of all electrically operated equipment, control and

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NOTE: This is a new Part I, Bulletin No. LR-8, Interior Installations, Electrical, and replaces the previous Part I which was obsoleted in October 1963. The material contained in the previous Part I has been completely revised.

disconnects, lighting fixture outlets and switch controls, receptacles, service equipment, metering locations, branch and feeder circuit control panels, and feeders and branch circuits (which should be shown connecting outlets and numbered to indicate circuit).

Details of transformer vaults, metering and distribution centers, and any special equipment, including wiring diagrams showing time controlled circuits, should be prepared.

After the branch circuiting design and the point(s) of branch circuit distribution have been determined, riser diagrams, general feeder layouts, and electrical drawings generally can be completed.

To accommodate the building master disconnect, meter center, and/or distribution center inside a building where there is no basement, the floor plan must provide space for the required equipment. Where this equipment is required to be on the exterior of a building, a location that will permit at least partial concealment by planting or other means will prevent marring the exterior appearance of buildings.

Incorporate not less than the minimum requirements of governing rules and regulations, as prescribed by:

National Electrical Code (latest edition)

Local Municipal and/or State codes and regulations

Any other governing bodies

whichever is more restrictive, except that any requirements of local, State, or other governing bodies' codes and regulations which appear to be unnecessarily restrictive should be reviewed with the proper authorities in an effort to secure modifications and waivers.

Work shown on drawings contrary to rules and regulations and not covered by waivers requires changes during construction and involves unnecessary expense.

For uniformity in use of electrical wiring symbols, select from the standards of the American Standards Association those applicable to the requirements of the project.

b. Distribution Centers. Distribution centers may be divided into three groups: branch circuit, feeder, and main. Under all conditions provision should be made for branch circuit centers, while feeder and main centers will be installed only if the design requires them.

The location of distribution centers depends on the type of building, meter locations, and electrical equipment served. In determining the method of distribution and type(s) of distribution, design a system which will reflect the lowest practical "economic cost," that is, the lowest initial cost consistent with low maintenance and operating expense.

(Cont'd)

(1) Branch circuit centers serving dwelling units should be conveniently located for the restoration of circuit protection, preferably within dwelling units, especially if electric cooking is included in the utility services. Electrical appliances rated at more than 1650 watts, such as electric ranges, require disconnecting means other than as a part of the appliance and readily accessible to the operator.

Branch circuit centers usually consist of two or more general purpose lighting circuits and at least two small appliance circuits, depending on the size of the dwelling unit, with the addition of a high capacity circuit for cooking when required.

No facilities should be provided for installation of automatic laundry equipment or air conditioners in dwelling units, without prior approval of PHA.

The branch circuit center under certain conditions may include the meter socket in addition to the panel proper. For 1-story units and 2-story row houses, back-to-back combination branch circuit centers and metering though available for installation in exterior wall construction of thicknesses varying from 4½ inches to 7 inches has not always been possible. The meter socket faces on the exterior of the wall, with the branch circuit center accessible from inside the dwelling unit. It requires careful planning to avoid interference of structural members.

By decentralizing the branch circuit protective devices the tenant has access to the branch circuit center and responsibility for restoration of branch circuit protection, thereby reducing operating maintenance cost, with use of standard equipment.

(2) A feeder distribution center or several centers from which feeders extend to branch circuit centers are usually required in apartment type buildings. This arrangement may also be necessary for certain types of row houses and two-story buildings with flats. Where electric energy is purchased wholesale, it is recommended that the design provide for future installation of 100 percent check-metering to permit control of consumption (See PHA Bulletin No. LR-11 for exception). For row-house buildings the location of individual dwelling unit check-meters will be governed by the design and location of branch circuit protection.

Feeder distribution centers should not be located within crawl spaces or in a dwelling unit.

In high-rise structures distribution centers should be located, in allocated designated spaces, on each floor or on intermediate floors depending upon the number of units on each floor and closet space available. Where check-metering will not be installed, the distribution centers may be located on the lowest floor with a single vertical feeder for each riser of dwelling unit panels.

(3) Service disconnect should be located within the building to be served and adjacent to branch circuit or a part of the feeder distribution
(Cont'd)

center. The disconnect should be readily accessible to maintenance operator and beyond the reach of children. Under certain conditions, in single, twin and row-house buildings the disconnect should be located on the exterior of buildings, with the handle about five to six feet above grade.

c. Wiring. Interior wiring should be designed on the basis of a voltage drop not to exceed 3 percent from point of building service connection to the last outlet, with all lamps and devices in operation.

In nonfireproof structures armored cable, nonmetallic cable, or knob and tube wiring may be used, subject to the requirements of all governing bodies having jurisdiction.

Conductors in raceways should be lead covered, moisture-resistant rubber covered, or other type especially approved for use, where raceways are installed: (1) underground; (2) in concrete slabs or other masonry in direct contact with earth; (3) in wet locations; or (4) where condensation within raceways is likely to occur.

Service entrance conductors should not be run through hollow spaces of, nor within, frame buildings for a distance greater than five feet, unless provided with overcurrent protection at their outer end.

d. Outlets. The recommended minimum requirements of the National Electrical Code regarding number of convenience outlets per room have been adopted as recommended minimum requirements for PHA-aided low-rent housing projects. Included below in this section are recommended practices regarding installation of electrical outlets.

Avoid an excessive number of convenience outlets. Adequate outlets, however, as may be required by the plan layout should be provided to discourage an excessive--and often dangerous--use of exposed extension wires by tenants.

Avoid running branch circuits of one dwelling unit through outlets of other dwelling units.

Do not locate outlets, conduits, etc., in partition at end of bathtub; they interfere with repair and replacement.

In stairhall of row houses and three-story flats, locate three-way switch at top of stairs not less than two feet from the top step to minimize the falling hazard when groping in the dark.

As far as practical, avoid the installation of outlet boxes in exterior walls wherever a vapor barrier is to be installed; where outlets must be so placed, detail the work so that the vapor seal is unbroken at these points.

Where foil insulation is used all metal outlets installed with nonmetallic cable installation should be grounded.

(Cont'd)

In crawl spaces consideration should be given to providing a receptacle, switch, and lighting fixture outlet near entrance and additional receptacle and lighting fixture outlets to permit use of 50-foot extension cord for a small degree of illumination in the crawl space area. These outlets should not be connected to a tenant circuit protection panel.

Install devices located on opposit faces of the same wall back-to-back where practical.

The convenience receptacle for refrigerator connection should be placed at such height and location as to also serve the work table, when the kitchen layout will permit.

(1) Lighting Outlets. Locate ceiling and wall lighting fixture outlets to provide efficient distribution and illumination. Locate ceiling lighting outlet in kitchen off-center (12 inches from edge of apron of sink and on center line of sink) to provide a higher degree of illumination at sink and work surfaces. Check fixture location for possible interference with cabinet doors. Bathrooms may be provided with either ceiling or bracket fixtures. Center the ceiling lighting fixture outlet over lavatory 12 inches from wall; center the wall bracket lighting outlet above medicine cabinet, with ample clearance between fixture and medicine cabinet door. Ceiling outlet in living room and bedrooms is considered more satisfactory than wall bracket outlet, for general distribution of illumination. In units for the elderly, all fixtures shall be mounted at accessible heights so that climbing will be unnecessary when replacing light bulbs.

(2) Switch Outlets. Wall switch outlets are to be provided for control of ceiling fixtures except where pull cord control is more advantageous. In units for the elderly all light fixtures should be wall switch control. Wall switch outlet should be located approximately 36 inches above floor. In public spaces, where accessible to children, wall switch outlets should be located a distance of approximately 5'- 0" above floor.

(3) Receptacle Outlets. Base receptacles should be of the heavy-duty type. Wherever feasible, combine receptacle and switch in one outlet box. In all units designed specifically for the elderly, receptacle outlets in all areas, except when combined with wall switch or in kitchen and dining space, should be located at a height above floor to avoid unusual bending over - 18 to 24 inches should suffice.

(4) Nondwelling Spaces. For community, and management and maintenance spaces, electrical layout should be designed to provide efficiency in operating in these areas. The following are items which should be considered:

(a) Fan receptacle outlets should be provided in office space if there is no other provision for summer cooling.

(b) A switch with pilot on exterior of vault and paint storage room for control of light fixture and other equipment.

(Cont'd)

(c) A clock outlet in general office space and in manager's office.

(d) Sufficient number of receptacle outlets in general office spaces to serve electrical office equipment.

(e) Adequate telephone requirements, including space for public telephone.

(f) Explosion-proof equipment for Paint Shop.

(g) 220-volt service for Maintenance Shop.

(5) Community Laundries. When Project community laundries are planned, provide outlets for (1) nonautomatic and automatic washing machines, (2) mechanical drying units, (3) ventilating fans, and (4) artificial illumination. Provision for receptacle outlets for automatic washing machines should be based on one washing machine being adequate to serve 17 families, and operation being under the supervision of management, tenant groups, or distributor. It is important that the Local Authority decide the method of operation at an early date to assist the designing engineer in arranging equipment and the means for proper services. The following are types of equipment indicating the outlet requirements:

(a) Nonautomatic washing machines will require receptacle outlet at the double laundry tray (either drop cord type or wall-mounted type alongside of tray).

(b) Automatic washing and drying machines will require a receptacle outlet on the wall approximately 4 feet above finished floor.

(c) Ventilating fans will require an outlet for connecting service to fan motor.

(d) Means for grounding the equipment should be provided, regardless of the type of equipment which may be installed at a later date, to avoid unnecessary expense.

A survey of a number of low-rent housing projects where ironing boards and hot-plate units had been installed indicates that the usage does not warrant providing for these services, as ironing is normally performed in dwelling units, and hot plate units are a source of unusually high maintenance—unsightly when improperly maintained, and a source of hazard by accidental burning. Therefore, no provision should be made in a community laundry spaces for this purpose.

Outlets for illumination should be so placed that the distribution of light will fall directly on trays, work tables, and other pieces of equipment.

As supervision of laundry space is desirable, provision should be made to control the lighting and electrical equipment of laundry spaces, excluding ventilating fan, by means of a time-clock control device.

(Cont'd)

e. Protective Devices. Overcurrent protection for dwelling unit circuits should be provided by circuit breakers or plug fuses of the tamper-resistant type with screw base adapters. Carefully choose the type of device which is most suitable on the basis of (1) initial cost; (2) comparative cost of maintenance, repair, and replacement; and (3) operating conditions peculiar to the locality.

Where fuses are to be used, provide tamper-resistant plug fuses of a type which will prevent (1) the insertion of fuses of greater capacity than the rating of the adapter, (2) the insertion of coins or other metal between the blown fuse and base of socket. This type of fuse requires the installation of a screw base adapter in the standard "Edison base" socket. The initial cost is slightly higher than the standard plug fuse; but better protection is afforded the circuit wiring, and maintenance costs are reduced.

With branch circuit centers located within dwelling units replacement of fuses should be a tenant responsibility. In some localities where local stores do not carry adequate stock of fuses, the management may find it necessary to maintain a supply for resale to the tenants or arrange with local stores to supply the tenants' needs.

The most satisfactory division of circuit protection for dwelling units appears to be:

(1) General purpose circuits (15 amp.) to serve fixed lighting outlets throughout the unit. Provide minimum of one circuit for each 500 sq. ft. of floor area or fraction thereof.

(2) Appliance circuits (20 amp.) to serve receptacle outlets only in kitchen, dining space, and utility room.

(3) Furnace heating equipment (15 amp.) circuits to serve individual tenant heating plant electrical equipment; install protective device at equipment as required.

(4) Cooking range and/or water heater circuits when provided, shall be of sufficient capacity based on rating of proposed equipment.

(5) Individual room air-conditioner circuit when approved by PHA (See criteria for Planning and Design of PHA-Aided Low-Rent Housing, Low-Rent Housing Manual Section 207.1, paragraph 9a.) shall be of sufficient capacity for 120 or 240 volt equipment.

Where thermal circuit breaker protection is to be used for branch circuits, it is important to provide proper time lag protective devices ahead of the branch circuits.

(Cont'd)

The protective devices in the main service feeder distribution center and branch circuit panel installation are to be planned so that an overload on one or more of the dwelling unit circuits will not cause the protective devices ahead of the branch circuits to operate before the branch circuit devices open, resulting in a complete shut-down to the particular dwelling unit group.

f. Signaling and Communication. The various facilities for signaling and communication may be divided into the following groups: door call system, emergency call system, fire alarm system, telephone system, radio system, and television system.

(1) Door Call System. Where means for calling are necessary, a mechanical device mounted directly on the dwelling unit entrance door may be used (rather than an electric calling system, which is more expensive to install and maintain).

In high-rise building where management cannot control the free movement of persons other than residents, creating annoyance or otherwise interference of the normal daily routine of tenants, consideration may be given to providing an automatic (main entrance) door opener and means for communication between main entrance lobby and each apartment. Although this type of equipment increases development costs, it may decrease building maintenance costs and provide peace of mind to tenants. Therefore, it should be given consideration particularly in structures designed specifically for elderly.

(2) Emergency Call System. In projects specifically designed for elderly means should be provided to permit the tenants to summon emergency aid.

(a) Provide an emergency call station in the bathroom (a second call station if used, located in the bedroom next to head of bed) with a signal (audio and visual) in the adjoining dwelling.

(b) Same call station arrangement with signal (audio and visual) located over or adjacent to the dwelling entrance door. Audio signal should be clearly and distinctly different from any other audio signal.

(c) Same call station arrangement with signal transmitted to a central location (under 24 hour supervision of management).

(d) Emergency call station, if possible, when operated should be arranged to release apartment door lock to allow entry to unit (without resorting to key) should tenant become incapacitated. Resetting of call station to normal to reset lock.

(e) Door release should be constant duty, 30 ohms at 24 volts. Call stations should be toggle type switch (1 or 2 pole as required) and may be pull cord operation through an eye guide in the plate. This type of station permits extension of pull cord to tenants desired location and permits operation from floor or bath tub.

(3) Fire Alarm System. As a general rule, fire alarm stations and gongs will be required for all high-rise type buildings (with elevators). For walk-up type apartment buildings consult with the local governing board having jurisdiction concerning necessary requirements. Final location of stations and gongs should have approval of local governing board.

(Cont'd)

(4) Telephone System. The desirability of planning for future telephone installation in the individual dwelling units is generally recognized. This should consist of minimum adequate roughing-in to permit at a later date the introduction of cables, cable terminals, protectors, and wires--with minimum cutting of structures. In units for the elderly, telephone outlets should be located for convenience of tenant, preferably convenient to bed location.

Experiences of 13 projects with 5300 dwelling units indicate that the demand for service varies from 35 percent to 115 percent (average overall, 57 percent) of the number of dwelling units in a project.

Consult with the local telephone company regarding requirements for their facilities and experience in providing the most economical layout. The services of their engineers are usually available without cost for consultation and advice on all matters pertaining to telephone systems for low-rent housing projects. In some localities the telephone company will pre-wire buildings at no cost to the project.

In general, the following provisions for the future installation of telephone service are considered adequate for low-rent housing projects:

Single, Twin, Row Houses and Flats Without Basement 1/

Service sleeve, with closed bushings, through exterior wall for each dwelling unit (none if exterior wall is of wood).

Row Houses With Basement

Sleeve through a closet floor (if of concrete) in each dwelling unit.

Service sleeve or sleeves through exterior wall.

Flats and Apartment Type Buildings (Walk-Up) With Basement

First floor dwelling units--sleeve through a closet floor (if of concrete) in each dwelling unit.

For each dwelling unit above first floor--a vertical raceway extending to the basement or crawl space.

Service sleeve or sleeves through exterior wall.

Apartment Type Buildings (Elevator)

Vertical raceway near center of building and branch raceway to dwelling units, or sleeve in the corner of a closet in each dwelling unit for installation of exposed cable by the telephone company.

For buildings with six or less dwelling units, without basement, telephone protective equipment may be mounted on the exterior of the building.

(Cont'd)

1/ For service to each building, telephone company engineers must be consulted, regardless of detail and location of sleeves through exterior walls.

Buildings with more than six dwelling units and without basement will require a closet (30" high, 20" wide and 10" deep) accessible from the exterior of the building, for housing the individual protectors or "L" type cable terminal, as may be required. The provision of such a closet would preserve the appearance of the building. For apartment-type buildings (with elevator) provide space on each floor or alternate floors, near the center of building, for telephone terminal connection equipment as prescribed by the local telephone company.

(5) Radio System. Do not provide any raceway in the building structure for radio reception facilities, since present radic receiving equipment is provided with built-in antenna satisfactory for normal reception.

(6) Television System. In most localities, indoor or built-in antenna system will provide ample signal strength for reception; however, in areas where the need for an outdoor antenna is considered necessary, a proper engineering survey should be made to provide the best adaptable installation. (The services of a T.V. System installer would be helpful in obtaining a proper survey and the best adaptable system layout). Installation of master T.V. antenna systems should be considered, particularly for low-rise projects, to avoid installation of forest of masts distracting from the appearance of the project and probable maintenance costs for roof repairs. Distribution system may be overhead or underground to each unit.

g. Electric Meters. Meters should be installed only after operating experience on the project has indicated the necessity for them. When it is determined that a check on current consumption is required, the installation of 100-percent meters is advisable, since metering only part of the tenants at a time has not proven satisfactory. (See PHA Bulletin No. LR-11 for exception).

Although it is desirable that meter location be convenient to permit meter reading by the tenant since it enables him to check his consumption against the amount allotted and included in his lease, such location also has its disadvantages.

Where project service is centralized, as in heating plants where it may be difficult for the management to estimate project energy consumption, facilities for metering the electric energy for the project service portion are very desirable.

Metering equipment and meters, when installed, should be locked in place by means of seals secured with a project-stenciled clamping device.

(1) Arrangement. Metering facilities required for future installation of tenant check-metering may be in the form of socket or receptacles to receive detachable type meters.

(Cont'd)

(2) Locations. The advantages and disadvantages of placing meters "inside" or "outside" of dwelling units should be carefully studied.

Locating metering equipment within the dwelling unit will permit tenant to observe amount of energy consumed, simplify the wiring to the dwelling unit, and avoid disputes over energy charges (if any), but it will create a problem for management, scheduling access to apartments--sometimes encountering locked doors--, listening to tenants complaints which should be the problems of others on the project staff, and increasing the time required for reading of meters within a definite schedule.

When metering is installed outside the dwelling unit, tenant and management could, normally, both read the meter at their discretion, thereby, allowing metering to be performed without interruption.1/

(3) Types. All electric meters should be provided with cyclometer dials, thus precluding the necessity of instructing both tenants and operating personnel in the proper method of reading the total consumption of energy used.

Where practical and load permits, service to dwelling unit should be single phase, 3-wire, 120/240 volt so that low cost meters may be used. On a 3-phase, 4-wire secondary service, a 3-wire, 120/208 volt service to dwelling unit panel or branch circuit center will require the use of a two-element (network) meter costing approximately 100 percent greater than the standard 3-wire, 120/240 volt meter.

In some areas where the regulatory body permits its use, single element meters designed for 120/208 volt service may be considered, provided the maximum load does not exceed 60 amperes. These meters require factory calibration and are comparable in cost to the standard 2 element, 120/240 volt meters.

h. Lighting Fixtures. In the selection of lighting fixtures for dwelling units, consideration should be given to the difficulties which have been encountered in management operations. Low initial cost with low maintenance and repair expense are factors in deciding the best and most suitable types of lighting fixtures.2/

Although many tenants will own portable lighting fixtures, it is still important that every room in the dwelling be equipped with a fixture.

(Cont'd)

1/ In flats and apartment type buildings of three or more stories in height, where it is necessary to provide feeder distribution centers and individual branch circuit centers, meters located at distribution centers will not increase the cost, and meter-reading cost will result in minimum operating expense.

2/ It will be noted in the general discussion of lighting fixtures for dwelling units no mention is made of fluorescent or other newer types of lighting fixtures. Such new developments are not prohibited under PHA standards, nor does the PHA wish to imply that it does not favor any advance in illuminating methods. However, based upon experience, not only in initial but in operating costs it appears that the type of illumination recommended herein for dwelling units is well adapted to low-rent housing.

Include on electric drawings or in the Specification a schedule of the fixtures required for the various locations, with references to (1) detailed sketches, or (2) trade names and catalog numbers prefixed by the phrase "similar in design and equal in quality."

For convenience of management operation, lighting fixtures in stairways and hallways scheduled for use only from sunset to sunrise or from sunset to midnight should be automatically controlled by time switches (supplemented by relays where necessary).

(1) Control. The control of all fixtures should be by means of wall type switches or toggle switches mounted integral with equipment. Pull chain socket-type fixtures should not be specified as they are costly to maintain, requiring replacement of complete socket and/or fixture when chain is broken.

(2) Intensity of Illumination. Recommended artificial illumination in the dwellings is an average of five to seven foot-candles, measured in a horizontal plane 30 inches above the floor area in each occupied room (utility rooms excepted) with thirty (30) to forty (40) foot-candles normally allowed at points where reading is done and specific tasks are performed; on stairs and in passageways an average of five (5) foot-candles is considered adequate. In public vestibules, halls, and stairways, provide approximately 1 watt per square foot of floor space. The following lamp sizes for dwelling spaces, and types of control are recommended:

(a) Living Room - 100-150 watt - wall switch

(b) Bedroom - - 60-100 watt - wall switch

(c) Kitchen - - 100-150 watt - wall switch

(d) Bathroom - - 60 watt - wall switch

(e) Halls - - - 40 watt - wall switch or fixture toggle switch

(f) Utility Room - 40 watt - wall switch or fixture toggle switch

Exterior front and rear entrance lights under the control of tenants are not generally considered necessary for one and two story structures when electric service is wholesale and where project lighting provides sufficient illumination of entrances and porches. However, when electrical energy is retail and when project and street lighting is inadequate, entrance lights may be provided and should be located above or at side entrance door to properly illuminate the features of persons calling at the dwelling unit. In units for the elderly consideration should be given to the special problem of adequate lighting outside the apartment door so that the resident easily can locate the lock at night.

(3) Types.

(a) In dwelling spaces selection of fixtures requires careful study by the designer. Fixtures shall be of good quality, of simple and sturdy design

(Cont'd)

with durable finish, interchangeable parts requiring low maintenance and replacement, and provide maximum efficiency of illumination. When shades or enclosing globes are provided, their removal shall be simple, for convenience of tenant replacement of lamp bulbs.

(b) In public spaces fixtures for hallways, stairways, and/or other unsupervised public spaces should be of type which will prevent removal of lamp bulbs by unauthorized persons, and eliminate breakage of enclosing globes, lenses or other light distribution covering. To prevent unauthorized removal of lamp bulbs in fixtures (with or without enclosure) consideration should be given to providing left hand threaded sockets, or means for locking lamp bulb in place by a special key, or providing a suitable guard locked in place by a special key.

To prevent breakage of lamp bulbs and covering, fixtures should be provided with a break-resistant translucent covering material (guards may also be used as an added precaution). The one tube, ceiling florescent type fixture with break-resistant covering should be considered as it has been effective in combating this problem wherever trial installations have been made.

Where slab construction provides sufficient thickness, consideration should be given to installation of an inexpensive recessed type fixture with suitable guard.

Public vestibules and entrances may require some special type of fixtures to suit the architectural treatment.

Community space, management offices, and shops will require well lighted areas commensurate with the type of function to be carried on. Consideration should be given to the use of florescent type fixtures which are pleasing in appearance, have longer lamp life, higher intensity watt/sq. ft., more uniform illumination, adaptable to harmonious architectural treatment, and produce less heat. This should be weighed against higher initial cost, higher operating cost due to more equipment to maintain, some stroboscopic effect, and extra care needed to dispose of worn-out bulbs because of inside coating materials being of poisonous substances.

For meeting rooms used for gymnasium purposes it may be advisable to provide enclosed globe type with incandescent lamp bulb fixtures with wire guards.

Fixtures should be properly located to reduce to a minimum shadows and dark areas. Locations subject to moisture, explosive vapors, or other special condition, and exterior basement entrances require special type fixtures.

Fixtures in basements should be located to avoid interference with piping to provide proper illumination of the area.

(c) In crawl spaces provide a nonmetallic type fixture mounted on an outlet box, and with an integral receptacle for the insertion of an extension cord for a portable lamp.

(Cont'd)

i. Options. Options should be allowed the contractor only when the Local Authority is unable to choose between systems or equipments which meet the requirements. When options are permitted, it is essential to specify equipments which are equivalent in function and in amount of labor and supplementary equipment required for operation.

j. Approval. In localities where required, layouts should be approved by the governing body before issuance of documents for bidding purposes.

ELECTRICAL

PART II - EXTERIOR DISTRIBUTION

GENERAL.

In public low-rent housing projects where the purchase of electricity is on a wholesale basis (through a master metering system) the Local Authority, in most cases, provides the distribution system.

The requirements governing selection of the type of electrical distribution system may differ somewhat from those of an average private housing development, where the distribution system is usually designed and installed by the local utility company. The principles of design and electrical requirements, however, of a low-rent housing development will be similar to those of a local utility company in serving the needs of residents in an average community. The essential needs are simplicity in design, a special need for economy, safety, efficiency of operation, and convenience. Since the cost of an electrical installation is low in proportion to that of other construction components, and since the uses for electric service are increasing at a rapid rate, special consideration for future needs is amply justified. Nothing that will result in unnecessary expense (initial or operating) should be included, but nothing that is essential to satisfactory long range use should be omitted. Electrical engineers should have an understanding of the problems inherent in low-rent housing, which often require more than average skill and originality to meet.

Designs based on the minimum requirements of the National Electrical Code and the National Electrical Safety Code will meet the fundamental objectives for safety; essentially they are safety codes, and installations made in accordance with their requirements will be safe when properly maintained. This does not preclude compliance with requirements of the local utility company and rules and regulations of the state utility regulatory board, when such requirements are mandatory within a locality.

The load characteristic of equipment to be served by electric energy is an important factor in the intelligent design of a distribution system. A project load consisting of lighting only results in a low load factor. With 100 per cent mechanical refrigeration added to the lighting load, the load factor will be higher. The addition of 100 per cent electric cooking, to lighting and refrigeration, will lower the load factor. Since the load factor is the ratio of the average load over a designated period to the peak load occurring in that period, it is important to consider heavy loadings for short durations caused by the type or types of equipment served.

If the rate classification under which a project will be served contains a penalty for a low power factor, consider installing power factor corrective equipment such as capacitors, providing the initial cost and expense of maintenance reflects

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a saving by creating a higher power factor. Motorized equipment contributes to a low power factor, particularly if motors are overloaded. (The relation of the power factor to the various types of electric services normally provided for dwelling units is discussed in PHA Low-Rent Housing Bulletin No. LR-11).

As an illustration of the foregoing, the installation of capacitors on a distribution system, serving 5462 dwelling units from a single management, showed an increase in the power factor from an average of 82% and 91% to 95-1/2% and 99-1/2% for the lighting and refrigeration load. An investment of $4323.00 (labor and material) for seven banks of capacitors (340 KVA) resulted in an annual saving of $4686.00. Further savings in maintenance costs will accrue from the longer life and fewer replacements of lamp bulbs, smoother operation of motor-driven equipment, and lower line and transformer losses.

There is no exact method for estimating or anticipating the type of load or duration of the demand periods that residents will impose on a system. The type of load and demand for similar projects may vary widely. For example, one project may be operating with a high power factor while another project in the locality, of similar size and design, and supplying the same type of service during the same period, may be operating with a low power factor. To serve their intended purpose efficiently, capacitors should be sized to suit existing conditions; undersized capacitors serve no useful purpose, and oversizing is just as bad. For efficient operation, allowance should be made in the system for the future installation of capacitors, if required, as determined after at least one full year of operation under occupancy. Consult with the local utility company concerning its experience and recommendations on the matter of power factor correction.

It is important to avoid conditions which have resulted in unsatisfactory conditions or in maintenance and replacement costs beyond amounts considered reasonable. The following examples are illustrations:

Yard lighting fixtures which are not equipped with the proper type of reflectors, (to deflect the light beam from windows of dwelling units) have been an annoyance to tenants.

Yard lighting fixtures without guards to protect fixtures and/or lamp bulbs have resulted in excessive replacement and maintenance costs.

A single control for project yard lighting and building hallways and stairway lights does not permit flexibility in operation.

The improper drainage of raceways, vaults and manholes has resulted in redesign and correction at considerable expense.

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1. OVERHEAD VERSUS UNDERGROUND DISTRIBUTION

a. General. The choice between overhead or underground distribution should be determined promptly after the site is approved and dwelling unit density has been determined.

Design the distribution system to meet not less than the minimum recommended requirements of the governing rules and regulations prescribed by:

National Electrical Code (latest edition)
National Electrical Safety Code
Local municipal and/or State codes and regulations
Local utility company's regulations
PHA Minimum Physical Standards and Criteria

Any local requirements which appear to be unnecessarily restrictive should be reviewed with the proper authorities in an effort to secure modification and waivers.

Work included which is contrary to rules and regulations (and is not covered by waivers) and which will have to be changed during construction will result in extra expense. Obtain approval of the final layout from the local and state organizations which have jurisdiction, before bids are taken.

b. Selection of System. While economy may be the prime factor in determining the type of distribution system to be designed, other reasons may contribute to the final choice. Esthetic reasons alone seldom justify the choice of an underground system, because of its greater initial cost. However, lower operating expense may justify its selection. Under certain conditions a section of the distribution system may be underground and combined with a portion overhead. For instance, an overhead primary with underground transformer stations and underground secondary conductors, or an underground primary with overhead transformer stations and overhead secondaries.

Some of the important factors which affect the selection of an overhead or underground distribution system are:

(1) Type of existing systems surrounding the project, and the trend in replacement of such systems.

(2) Contour of the project area and ground water level; extent of interference by trees and playgrounds.

(3) Safety factor, depending upon location and voltage of overhead primary lines.

(4) Severity and frequency of electric storms, sleet, ice formations and wind velocities.

(5) Soil conditions: The presence of rock will increase cost of underground work; soil of low-bearing value and high water content may cause difficulties with underground transformer vaults and manholes.

(6) Comparative costs: An underground system will cost more per linear foot than an overhead system. However, the site plan may lend itself to a comparatively short underground system in contrast to a longer overhead system, thereby allowing favorable consideration of the use of an underground system.

c. Type of Primary Circuit. The simplest form of primary distribution is the radial type (Fig. 1) which is considered most practical for low-rent housing. Although it lacks flexibility and does not offer insurance of complete service continuity, it should be given first consideration where topography and arrangement of load are advantageous.

The "ring" or loop system (Fig. 2) has greater flexibility than the radial system, with a certain degree of service continuity. The single loop, for overhead or underground distribution with means for disconnecting the loop at its midpoint, has been found to be satisfactory, though slightly greater in cost than the radial system.

The more elaborate loop system, with sectionalizing switches or disconnecting potheads at each transformer station, which allows by-passing of the station or feeding from either side of a loop, has definite advantages where a line break, even of short duration, may result in accident or loss of life. The cost, as a rule, prohibits such an installation in low-rent housing.

Where conditions permit, a modification incorporating the radial and loop can be applied to meet local conditions and requirements.

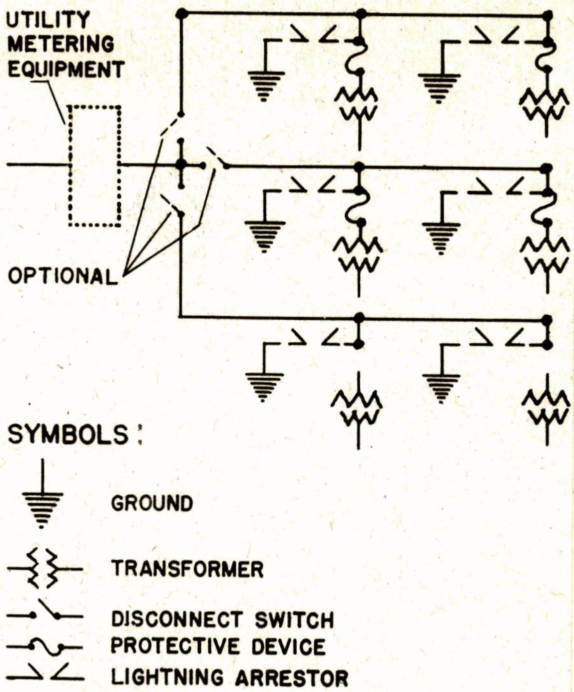


FIGURE 1. RADIAL SYSTEM

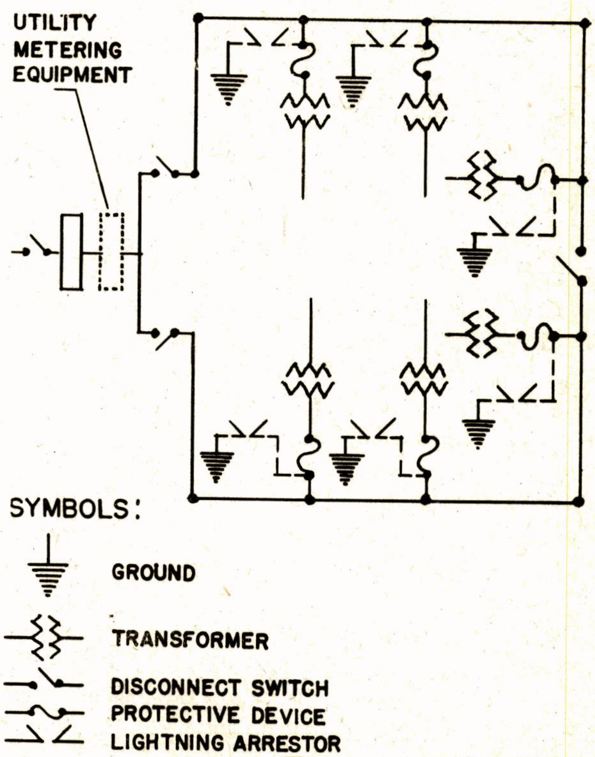
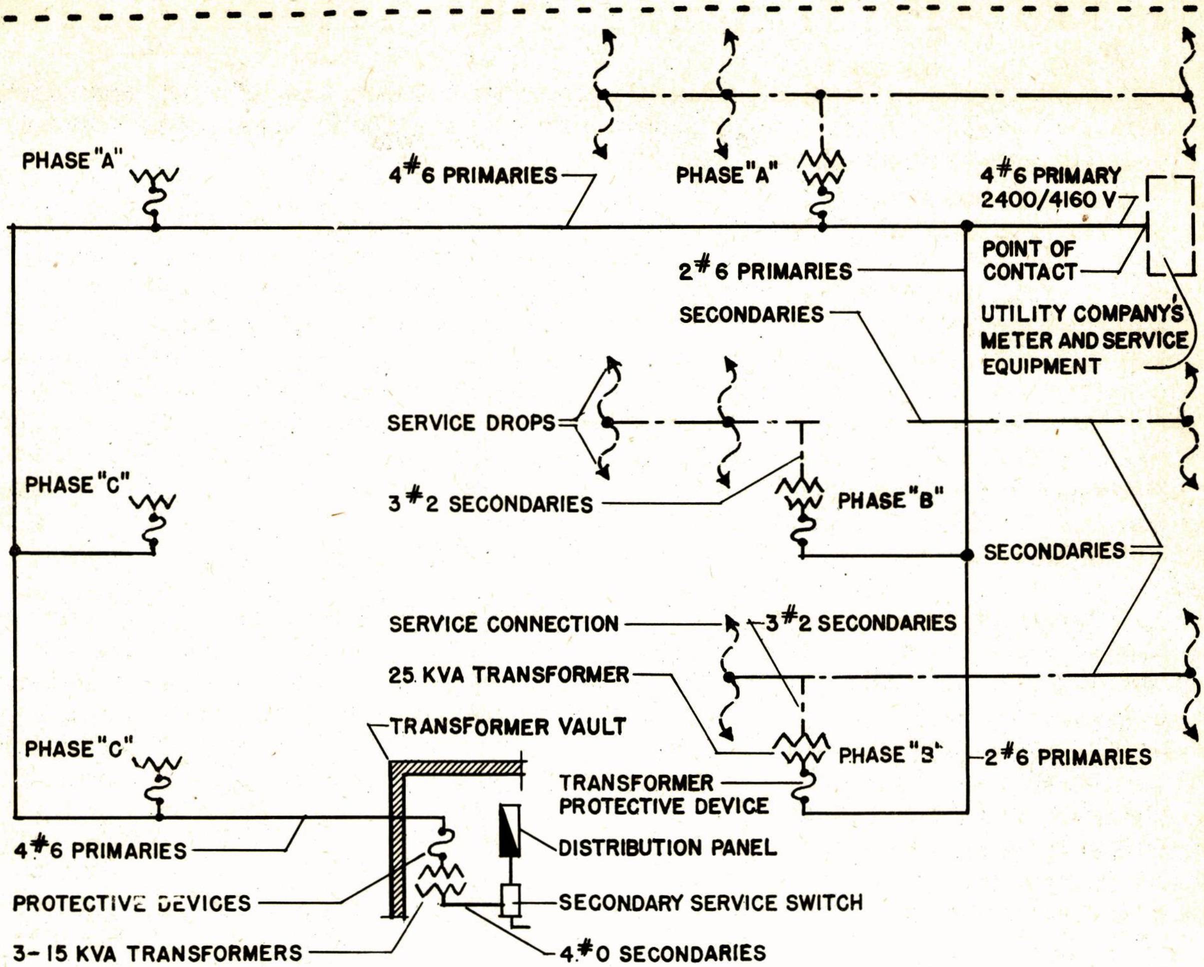


FIGURE 2. LOOP SYSTEM



NOTE: SIZES INDICATED ARE FOR EXAMPLE ONLY

FIGURE 3. . DIAGRAM OF ELECTRICAL SYSTEM AND ROUTING

d. Feeder and Transformer Sizing. Fig. 3 illustrates the system and routing of an electrical distribution for a project, including the sizes of primary and secondary feeders, and capacities of the transformer protective devices and disconnects.

For estimating the demands of lighting, refrigeration and cooking for use in sizing "outside" distribution feeders and capacities of transformers, see Exhibit A. The estimated demands of lighting and refrigeration for use in sizing "outside" distribution feeders and capacities of transformers are shown in Exhibit B. These data are based on national averages, and should be used with discretion in application to specific local conditions.

Design the system with a minimum of transformer and cable sizes to obtain the lowest possible initial cost, and to simplify maintenance and replacements.

For exterior distribution, the voltage drop between transformer secondary and service contact at buildings should not be more than 5 per cent, based on demands shown in Exhibits A and B.

e. Generating Equipment. In general, the purchase of electric energy is less expensive than its generation. Comparative studies of purchased electric energy versus generated energy will not be required, unless: (1) the cost of purchased electric energy is in excess of two cents per Kilowatt hour, (2) the project contains a minimum of five hundred dwelling units, and (3) electric energy is to be available for lighting, refrigeration, cooking, etc., and domestic water heating will be provided by a central plant. Available fuels will determine the form of motive power, high pressure steam driven units in connection with central heating plants, diesel engines, or gas prime movers for generation. Each project will require individual study with respect to plant size, capital cost, operating expense, and general layout.

f. Local Utility Hook-up. Points of contact with the utility company lines are to be determined on the basis of negotiations with the company. The most common practice is a single point of contact with electric service metered through a master meter at this point. Several points of contact, each with a master meter, will contribute to lowering distribution and maintenance costs. Permission for totalizing the readings of the watt-hour meters should be obtained from the utility company, so that the total consumption may be billed at the lowest possible rate classification.

Where a choice is possible, and extended rates permit, the delivered primary voltage should not exceed 4 KV, and should consist of 4 wire and "Y" connected. This permits the use of nominal 2400 volt apparatus. Distribution of primary service within a project should not exceed 4 KV, since danger and hazard in operation increase as the primary voltage is raised.

On a 4 wire primary (4000 volts) it is frequently the practice to use a common neutral for the secondary and primary systems. This eliminates one wire and is, therefore, economical. Ascertain from the utility company if the neutral conductor may be required to take a phase potential, which would necessitate an insulated neutral on the project distribution system. In grounding the system, avoid inductive effects of currents flowing to the ground, which may cause trouble in communication lines.

Incoming high tension lines and master metering equipment should be located in or near the maintenance shops, or boiler plant, where practical.

2. DESIGN FOR OVERHEAD DISTRIBUTION

a. General. The overhead method of distribution may be accomplished by means of: (1) stringing conductors on pole structures and extending service conductors to buildings (see Fig. 4), or (2) by stringing conductors on the building structures, looping from building to building (see Fig. 5), or (3) by combining (1) and (2).

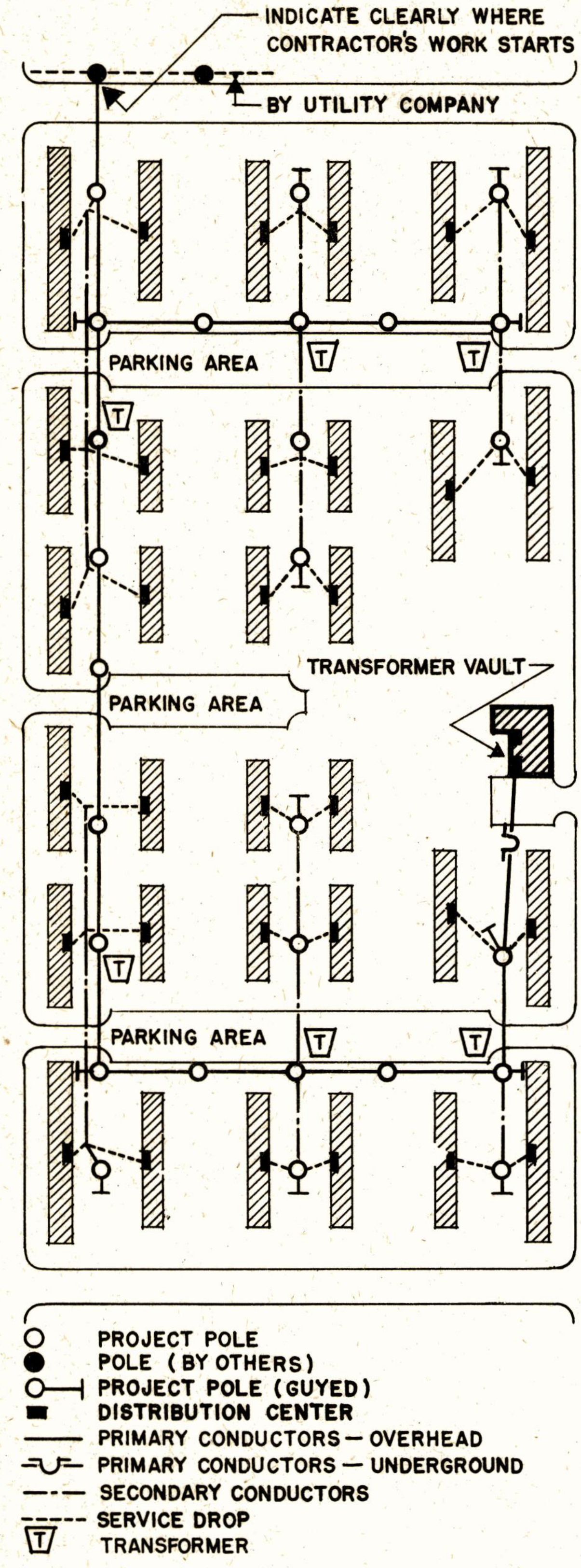


FIGURE 4 SAMPLE PLAN OF POLE LINE DISTRIBUTION SYSTEM.

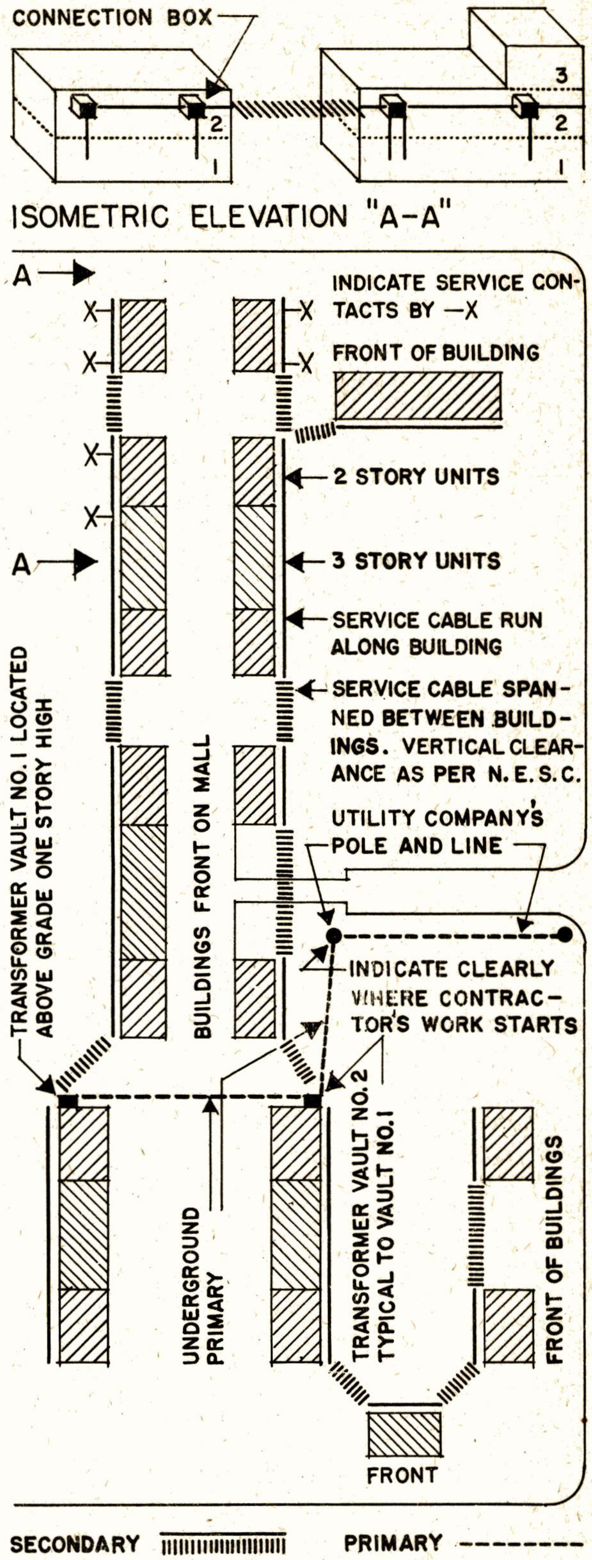


FIGURE 5
SAMPLE PLAN OF DISTRIBUTION SYSTEM WITH CABLE SUPPORTED ON BUILDINGS.

b. Poles and Lines. It is desirable to limit pole spacing to 125 feet. By placing transformer stations in the center of loads and limiting the sizes to one 37-1/2 KVA or 3-15 KVA per pole, the secondary lines will generally result in economical sizes, and the length of runs from the transformer station in any direction will not be excessive. Secondary runs which exceed 400 feet in length are considered uneconomical.

When loads imposed on poles are greater than can safely be supported (unbalanced conductors stresses at angles and dead ends), additional strength should be provided by the use of guys.

Stresses due to line angles between 10 and 60 degrees should be supported by a single guy placed to split the resultant load. Angles greater than 60 degrees should be guyed in both directions.

Figure 6 indicates the numbers and sizes of guys for varying conditions. The following example illustrates its use.

Conditions:

(a) 3 No. 4 Primary and 4 No. 1/0 Secondary
(b) Measured distance (d) - 20 feet
(c) Guy attachment height (H) - 36 feet
(d) Anchored lead (l) is 18 feet (a lead of 1/2 H or more is recommended)

Solution:

(a) L = 18/36 = 0.5, therefore, use column L = 1/2 H
(b) Wire equivalent is No. 1/0
    Sec. 4 No. 1/0 = 4. 0
    Pri. 3 No. 4 or 3x.39 1/ = 1. 17
    5. 17
    nearest whole number of 1/0 = 5 No. 1/0
(c) Referring to figures opposite 5 No. 1/0 under col. "1/2 H" a distance of 22 feet is the next larger figure to measured distance (d) or 20 feet.
(d) Therefore, one 3/8" guy with a 16" cone anchor should be used.

The extent of guying required should be kept to a minimum by avoiding needless changes in direction. Guys should be so located as not to obstruct walkways, play areas, parking areas, etc., or to interfere with the trees. Avoid slack spanning of wires between poles.

Clearance of service drop conductors over roadways, walks, lots and buildings should conform with the requirements of the governing boards.

Use bare conductors for voltages above 600 volts where practical; and insulated conductors for voltages under 600 volts. In heavy loading districts, a conductor

1/ Ratio of No./ft of conductor used to equivalent No./ft. of No. 1/0 as bare.

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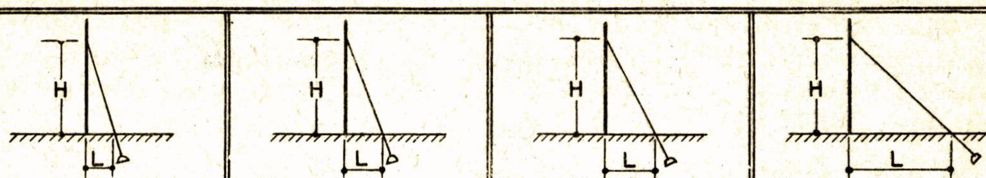
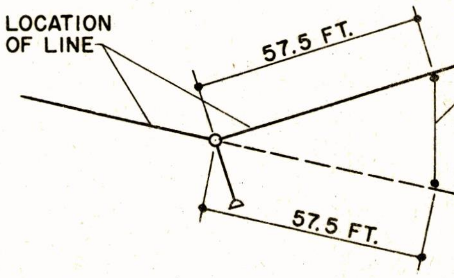


Lead "L"	1/4 H					1/3 H					1/2 H					H				
MAXIMUM DISTANCE "d" IN FEET																				
NUMBER OF #1/0's OR EQUIVALENT SIZES																				
1	15	*				20	*				28	*				44	*			
2	8	31	*			10	40	*			14	*				22	*			
3	5	20	41	*		7	27	53	*		9	37	*			15	*			
4	4	16	31	46	*	5	20	40	*		7	28	*			11	44	*		
5	3	12	24	37	49	4	16	32	48	*	6	22	50	*		9	36	*		
6	3	10	20	31	41	3	13	27	40	53	5	19	37	*		7	30	*		
7	2	9	17	26	35	3	11	23	34	46	4	16	32	48	*	6	25	51	*	
8	2	8	15	23	31	2	10	20	30	40	4	14	28	42	*	6	22	44	*	
9	2	7	14	20	27	2	9	18	27	35	3	12	25	37	50	5	20	40	*	
10	2	6	12	18	24	2	8	16	24	32	3	11	22	34	45	4	18	36	53	*
11	1	6	11	17	22	2	7	14	22	29	3	10	20	31	41	4	16	32	49	*
12	1	5	10	15	20	2	7	13	20	27	2	9	19	28	37	4	15	30	44	*
13	1	5	9	14	19	2	6	12	18	25	2	9	17	26	35	3	14	27	41	54
14	1	4	9	14	17	1	6	11	17	23	2	8	16	24	33	3	13	25	38	51
15	1	4	8	12	16	1	5	11	16	21	2	7	16	22	30	3	12	24	36	47
No. of 3/8" Guys	1		2	3	4	1		2	3	4	1		2	3	4	1		2	3	4
TYPE OF ANCHOR	Cone 8"	Cone 16"	Cone 23"	Log		Cone 8"	Cone 16"	Cone 23"	Log		Cone 8"	Cone 16"	Cone 23"	Log		Cone 8"	Cone 16"	Cone 23"	Log	

* Denotes "Dead End"

\# 1/0 Wire Equivalents:-
#6 solid = 0.245
#4 solid - 0.396
#2 stranded - 0.623
#2/0 stranded - 1.255
#3/0 stranded - 1.585
#4/0 stranded - 1.996

NOTE: For Straight Line Construction, Use the "Dead End" Columns Opposite Equivalent Loads to Find Anchor and Guy Sizes.



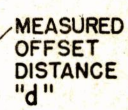


FIGURE 6 GUYING OF POLE LINE

smaller than No. 6 medium hard drawn is not recommended. No. 8 may be used in medium loading districts on short spans only. Secondary conductors larger than No. 2/0 are not recommended, as they are difficult to handle on overhead construction.

c. Secondary Distribution on Buildings. Where the arrangement and types of buildings permit, the stringing of the secondary along buildings rather than on poles will eliminate some poles. This method is not recommended where buildings are less than two stories in height.

The secondary cable should be of the standard 3 or 4 conductor (as required) concentric "service entrance" type, extended from the transformer location (building with vault or pole) to the building and run along buildings (close to roof line) spanning from one building to another. At span supports (on poles or buildings) use "concentric service cable clamps" to provide proper grip of cables.

At each point of tap along the building, install a rigid rust-proof "service connection box". In this connection box the concentric neutral should be opened and properly formed; the phase conductors shall be tapped by means of screws puncturing the insulation, creating a pressure contact between line conductor and tap. From the connection box, the service tap should extend to the metering and/or protective equipment.

d. Transformer Stations. Transformation should be in one step, to reduce core and copper losses, and switching equipment costs. Balance the load on each of the primary phases.

TABLE OF TRANSFORMER SIZES (KVA)
LIGHTING, REFRIGERATION AND COOKING LOADS

	Demand		Conventional type		Completely self-protected type	
No. of DU	KW per DU	Total	Size (KVA) of 1 Ø trans.	Size (KVA) of three 1 Ø trans.	Size (KVA) of 1 Ø trans.	Size (KVA) of three 1 Ø trans.
1	4.00	4.00	3	3 x 1.5	3	3 x 1.5
2	3.65	7.30	5	3 x 1.5	3	3 x 1.5
3	3.30	9.90	7-1/2	3 x 3	5	3 x 1.5
4	3.20	12.80	10	3 x 3	7-1/2	3 x 1.5
5	3.20	16.00	10	3 x 3	7-1/2	3 x 3
6	3.20	19.20	15	3 x 5	10	3 x 3
7	3.00	21.00	15	3 x 5	10	3 x 3
8	2.80	22.40	15	3 x 5	15	3 x 3
9	2.70	24.30	15	3 x 5	15	3 x 5
10	2.60	26.00	25	3 x 7-1/2	15	3 x 5
11	2.50	27.50	25	3 x 7-1/2	15	3 x 5
12	2.45	29.40	25	3 x 7-1/2	25	3 x 5
18	2.15	38.70	25	3 x 10	25	3 x 7-1/2
24	1.85	44.40	37-1/2	3 x 10	25	3 x 7-1/2
30	1.62	48.60	37-1/2	3 x 15	37-1/2	3 x 7-1/2
36	1.55	55.80	37-1/2	3 x 15	37-1/2	3 x 10
42	1.49	62.60	50	3 x 15	37-1/2	3 x 10
48	1.43	68.60	50	3 x 15	37-1/2	3 x 15
54	1.40	75.60	50	3 x 25	50	3 x 15
60	1.40	84.00	75	3 x 25	50	3 x 15

Study the comparative cost of the completely self-protected type of transformer without separately mounted auxiliary devices, and the conventional transformer with separately externally-mounted protective and disconnecting devices, since the selection may affect the size of transformers. (A study of the lighting, refrigeration and cooking loads on existing projects indicates that the most serious overload condition is encountered during the one hour period after the transformers have begun to operate at full load.)

A comparison of sizes of the conventional type transformer with separately mounted primary protection, and the completely self-protected type with internal secondary circuit breaker protection, appears in the table in the preceding paragraph 2d.

Transformer and cable sizes should be limited to the fewest possible number of sizes. The ideal condition is where all are of the same size.

3. DESIGN FOR UNDERGROUND DISTRIBUTION

a. General. Routing of underground raceways should be related to the contour of the finished site. Profiles should be developed to show elevations between vaults, manholes and buildings, and the location of service sleeves in buildings. Working drawings should indicate the elevations for proper installations.

Raceways, vaults, and manholes should be arranged to prevent the accumulation of subsurface and surface water.

The following methods of underground installations have proved satisfactory. Choose that which is best adapted to the project design and lowest in initial and maintenance costs.

(1) Metal raceway - encased in concrete.
(2) Non-metallic raceway - encased in concrete.
(3) " " " - buried directly in earth.
(4) Cable - buried directly in earth.

Raceways should be installed with a slope of not less than 6 inches for each 100 linear foot of raceway, and sloped toward manholes. Access covers, of manholes and/or underground vaults, should be raised above surrounding grades so that water will run away from openings. French drains and rock bed drains should be used only where soil conditions permit quick absorption of water.

Where the underground cable enters a building through a conduit sleeve, or where the underground duct and/or conduit terminates in a junction box on the inside of a building, the open space between the cable and the conduit or sleeve should be sealed at the point of entry or in the junction box (with a suitable sealing compound), to prevent the infiltration of any outside gases into the building (through the underground distribution system).

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b. Primary Cable. Lead-covered cable has proved satisfactory generally for underground installations, except in some coastal areas where chemical action has eaten through the lead sheath within a period of three to five years. Under reasonably normal conditions, the life of lead-covered cable is conservatively estimated as being about 50 years.

Non-leaded primary cables also have proved satisfactory in the short time they have been in use, but when consideration is given to the use of non-leaded cable, great care should be exercised in the selection of the type and grade.

c. Secondary Cable (voltages up to 600). Non-leaded secondary conductors specially designed for various soil conditions, have been in use for a number of years on a relatively large scale, and experience with this type of cable has been generally satisfactory. It is easier to handle and terminate and appreciably less expensive than leaded cable.

d. Parkway Cable (Generally). Cable designed for laying directly in the ground (where soils are favorable) is generally satisfactory, and will reduce initial cost.

e. Transformer Stations. A comparative study should be made covering the cost of placing transformers in: (1) vaults within buildings, (2) underground vaults independent of buildings, and (3) vaults or kiosks above grade. Kiosks could be developed in conjunction with comfort stations, tool sheds, or telephone booths. Underground vaults which are independent of buildings require subway type transformers and equipment costing more than standard equipment. Vaults within buildings or kiosks above grade will use standard equipment and offers greater accessibility with less expensive servicing and maintenance.

A typical transformer room layout using three single phase transformers is illustrated in Fig. 7. This layout shows the items to be considered in the design of a transformer room, including clearances around equipment, ventilation and fire protection.

Consideration should be given to the use of 3 phase transformer units in lieu of three single phase units in view of: (1) occupying less floor space, (2) less overall weight, (3) lower core losses, (4) one unit to handle and correct, and (5) lower initial cost. Transformer sizes should be the same throughout, where practical, to provide a minimum quantity of spare equipment for ready replacement in case of breakdown. Overhead bus and bus supports may be eliminated where the transformer primary bushings (3 phase unit) are taken through the side of the transformer, provided a steel box is welded on the tank, and the box contains oil cutouts.

Doors and openings to vaults and manholes should be large enough to permit removing or replacing equipment. Consult with the local utility company for other requirements which are not noted in Fig. 7. Foreign pipes and ducts should not be installed within switch-rooms or transformer vaults.

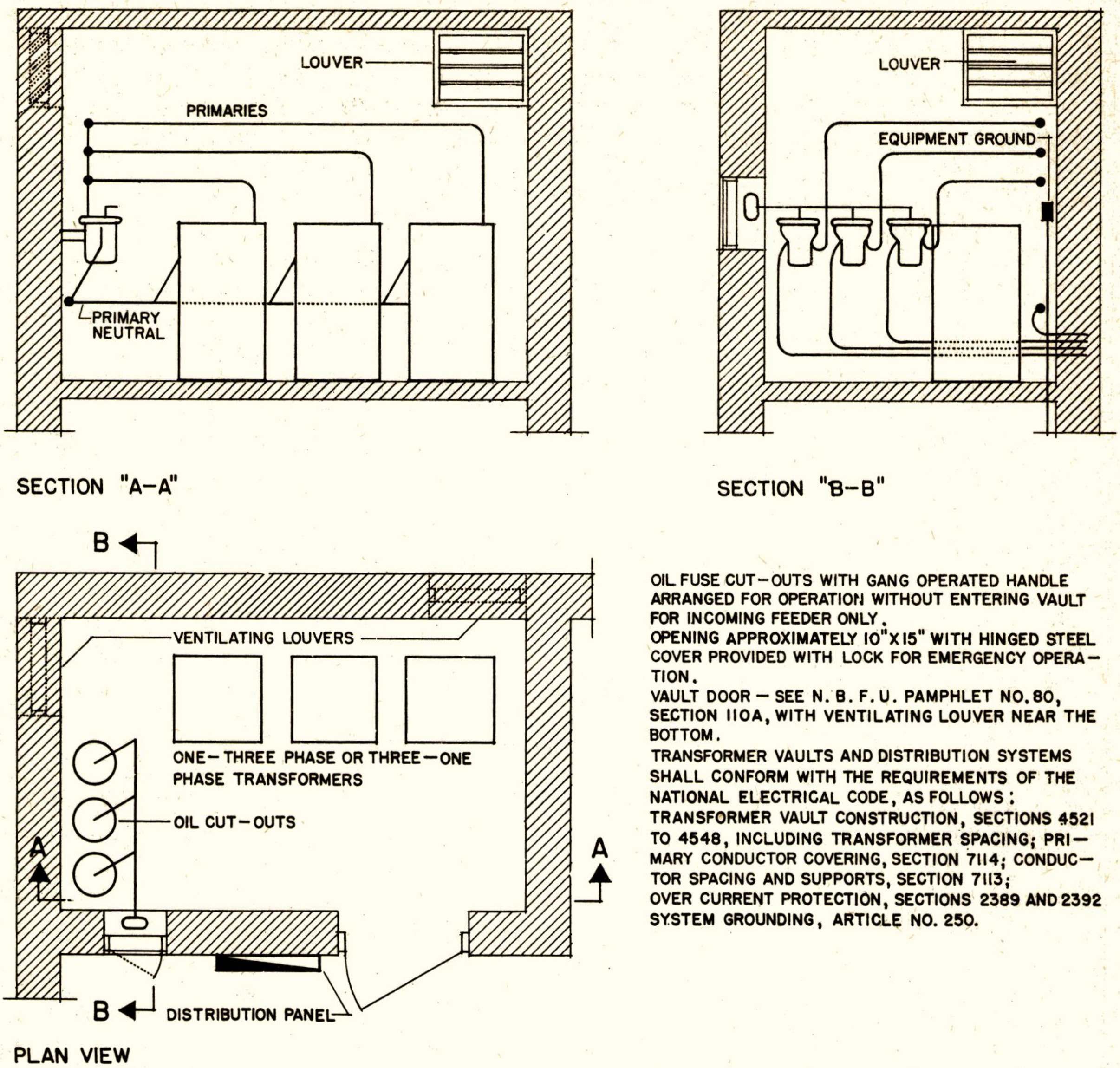


FIGURE NO. 7 LAYOUT FOR A TYPICAL TRANSFORMER ROOM.

The use of oil fuse cutouts for short circuits and overload protection on each phase, provides a simple and rugged primary disconnecting means. These cutouts are available for gang operation when load-break is desired. At a slight increase in cost, the operating lever can be extended to be operable from outside the vault, through a small wall opening.

When cutouts other than the oil fuse type are to be used, they should have isolating disconnect switches to permit replacing blown fuses without undue hazard. This arrangement requires added equipment and needs more space.

When single conductor leaded primary feeders terminate within a vault, the conductors should be carried direct to the wiping sleeve on the oil fuse cutout, thereby eliminating the use of a terminating pothead within the vault. The use of 3 conductor leaded primary cable requires the installation of a through type indoor pothead at the cable entrance. Disconnecting potheads should not be used, since they present an operating hazard.

"Load center power units" of capacities ranging from 50 to 150 KVA are also available for transforming electrical energy. The unit is factory assembled and shipped from the manufacturer as a complete, metal-enclosed load center unit, consisting of high voltage protection, meter transformer space, transformation, and low voltage protection. The only field connections required are to the primary supply and secondary distribution feeders. These "power units" are for use on single or three phase systems with transformation from 2400 volts to 240/120 volts or 208/120 volts.

Underground distribution centers, when required, should be provided with links or solid connections. Fuse protection should not be used in this equipment.

Primary service should not exceed 4.5 KV, if possible. The cost of reliable and adequate circuit interrupting devices at voltages above 4.5 KV are out of proportion to the cost of the equipment protected.

4. DESIGN FOR ILLUMINATION

a. General. In illuminating a site, consideration must be given to the lowest practical initial cost, consistent with low maintenance and operation, without jeopardizing safety to human life. Many individual factors must be considered in establishing the requirements for lighting a site, and each must be weighed according to its importance.

(1) Objectives. Proper site illumination promotes night time safety and convenience of persons on the project. It should protect such persons by enabling them to discern any other person walking or lurking about the premises. It is important that the faces and features of persons passing by should be recognizable at close range.

Personal safety should be assured by a lighting system which will enable a person to see any obstructions in his path, and all irregularities such as depressions, unevenness, stairs, excessive slopes, etc.

(2) Visibility. Objects at night are seen by silhouette, by contrast, and to a lesser extent by their brightness. It is desirable to place lighting units close to sidewalks and to other light colored backgrounds, rather than, for example, in the center of dark grass plots. Location of the units along the walk, where possible, will also throw direct light upon pedestrians.

(3) Intensity. High intensities of light are not necessary to show contrasts or silhouettes, but are desirable to obtain as uniform a distribution as possible. Since light varies inversely as the square of the distance,

a reflecting medium projecting much of the light away from its source is sometimes used effectively.

(4) Glare causes a decrease in the ability of the eye to see, and should, therefore, be eliminated as far as possible. Where glare is present, more light is necessary for the same visibility than where it is absent.

The higher the light source above eye level, the less the glare. When glare is considered as 1 at 32 feet mounting height, it increases to 8.4 at 12 feet mounting height.

Glare may be controlled by proper reflectors covering the lamp and distributing the light by controlled reflection, since it is caused by intrinsic brightness of the unit.

b. Area Lighting. Locate lighting units with relation to planting, building arrangements, building heights, walks and steps, contour of site, and existing and proposed street lighting.

The effect of trees and their interference with the distribution of light should be considered carefully in laying out area lighting. Units should be so placed that trees will not cause shadows over large areas. In the interest of safety, place a light source at steps and along walks to allow direct illumination from the light units.

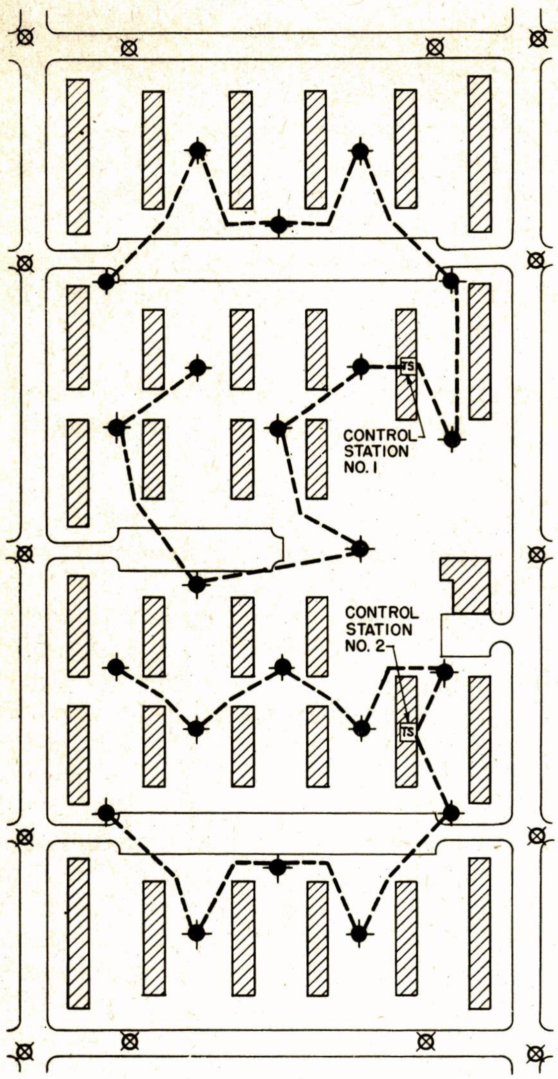
Building arrangements and their heights will govern the spacing and mounting heights of light sources. The higher the mounting height, the broader the light distribution. The mounting height should be related to building height; for example, two story buildings may permit 18 foot mounting heights, whereas one story buildings need mounting heights of 12 to 15 feet for pleasing appearance.

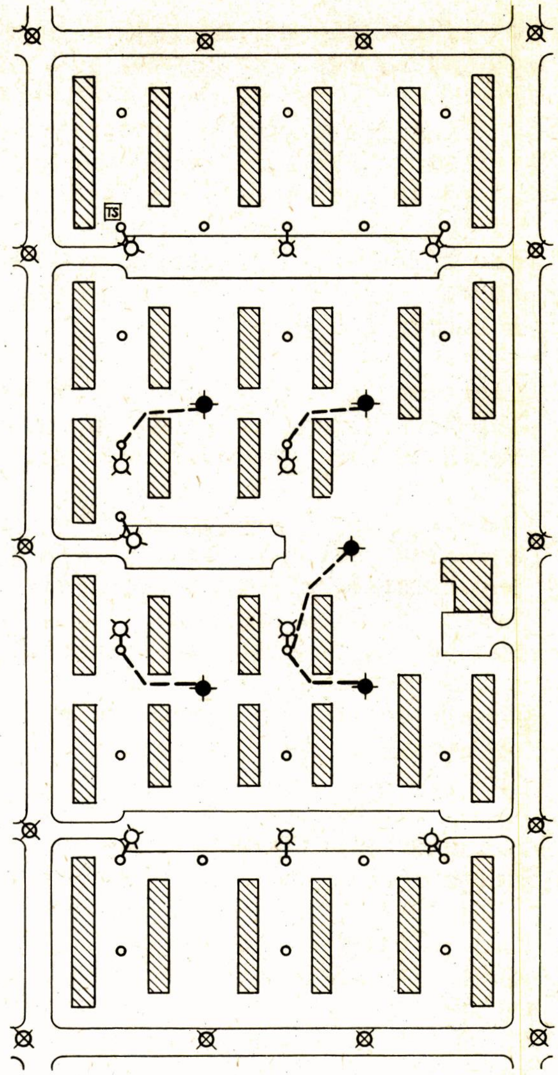
Site contours should be studied; a sloping site generally requires a larger number of light units than a flat site covering the same area. Spacing of units is important to obtain uniform distribution. To obtain uniformity, spacing between units should not generally exceed 12 times the mounting height. When appearance demands low mounting heights, closer spacing is necessary.

Any illumination of perimeter and through streets should be taken into account in placing lighting units. Where existing street lighting is inadequate, confer with the city officials to secure proper illumination. All street lighting on public streets within or bordering the project should be provided and maintained by the local municipality.

See Figs. 8 and 9 for typical arrangements for area lighting.

(1) Types. Stock designs cost less for installation and maintenance. See Fig. 10 for typical designs. Where the local municipality has adopted certain types of fixtures as standard, such types may be adopted for the project.





SYMBOLS

- PROJECT POLE
- BRACKET LIGHT ON POLE
- STREET LIGHT (BY CITY)
- YARD LIGHT STANDARD
- UNDERGROUND CONNECTION
- TIME SWITCH

FIGURE 8 SAMPLE PLAN OF UNDERGROUND YARD LIGHTING SYSTEM

FIGURE 9 SAMPLE PLAN OF COMBINATION OVERHEAD & UNDERGROUND YARD LIGHTING SYSTEM

Lighting units may be in the form of standards, pole brackets or fixtures mounted on buildings. The selection as to type depends upon the form of electrical distribution (overhead or underground) and on the types and heights of buildings. Initial and total overall operating cost should always be considered in determining the method of lighting.

Uniformity of light distribution is dependent upon the design and shape of the reflector. Uniformity of lighting will be further accomplished by higher mounting of lighting units, but mounting heights greater than 24 feet should be avoided.

Since outdoor equipment is subject to rough usage and abuse, non-breakable equipment should be selected. Units should be durable, with the lamps protected by some form of covering.

Posts for lighting standards are available in steel, concrete or wood. Wood posts cost less, but their life is much shorter than that of steel or concrete. Concrete posts, although not so widely used by municipalities for street lighting as steel posts, look well in yards of large housing projects, and require practically no maintenance.

A handhole with a locking cover should be provided at base of each standard for access to the connection between underground wiring and standard wiring.

(2) Control. Control the circuits feeding the area yard lighting by a single time clock, using pilot wire and contactors as required, for operation of conductors controlling the lighting circuits.

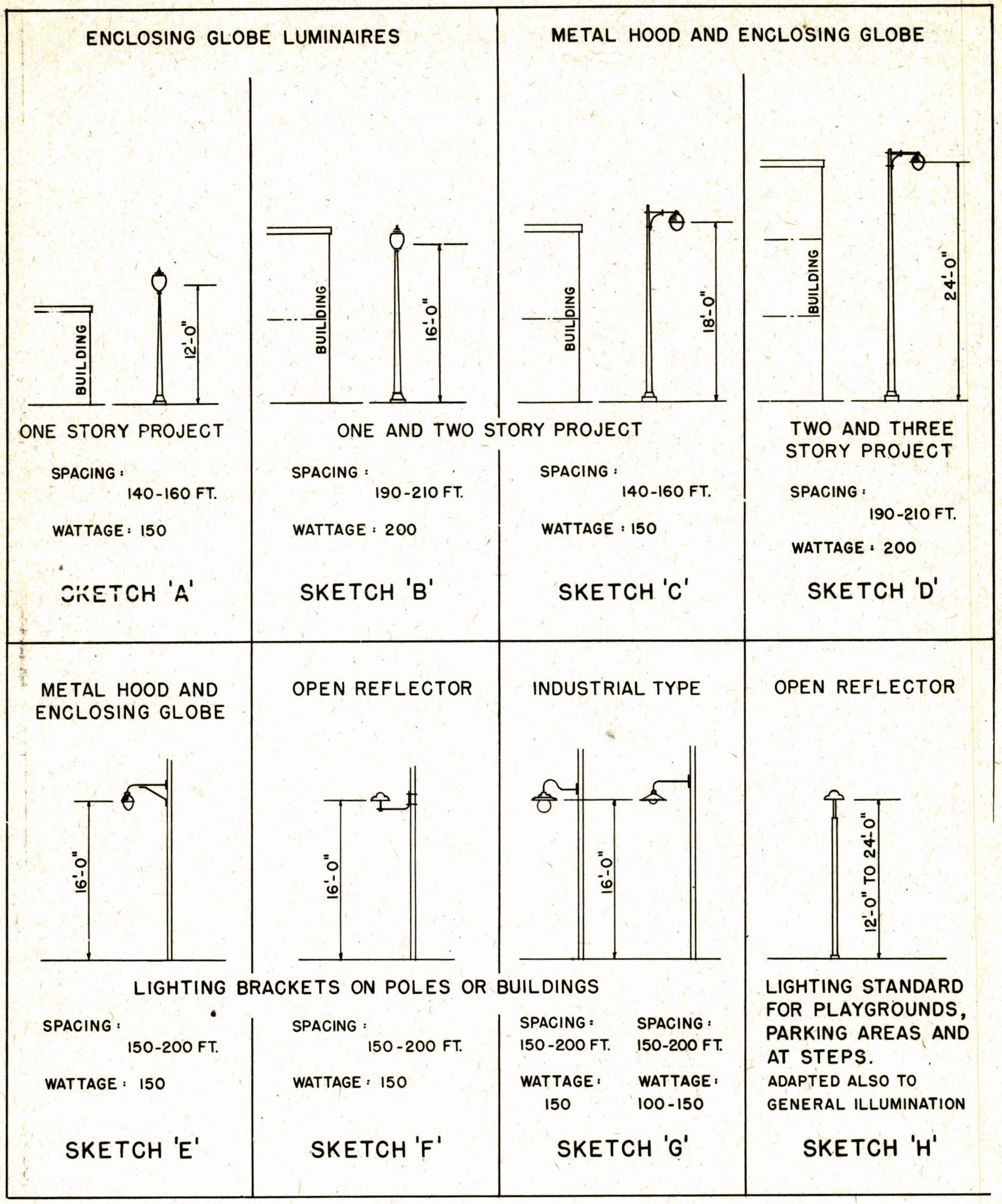
c. Play Area Lighting. The extent of illumination required for play areas should be discussed with local recreational authorities. Floodlights, if used, should be mounted on plain tubular poles or on adjacent buildings, and should be connected to project circuits with provision for separate metering and control. When floodlights are to be furnished by the local recreational authorities, provision of raceways and installation of cables, fixtures, etc., should be adequate.

d. Obstruction Lighting. It may be necessary to illuminate a high chimney or other obstruction in the path of air traffic. In such cases, the Civil Aeronautics Authority, Washington 25, D. C., should be consulted, and their approval obtained on the proposed layout and equipment.

5. DESIGN FOR SIGNALLING AND COMMUNICATION

a. Fire and Police Alarms. Consult with the appropriate city officials with regard to municipal fire and police alarm systems. The local municipality should provide and maintain new stations, relocate existing stations, and reroute or extend overhead or underground lines in connection therewith as required for a project.

This work, as required, should be performed in cooperation with the general construction contractor's work. All work to be done by the city should be



SKETCHES ARE SHOWN PRIMARILY TO GIVE AN IDEA OF THE SUGGESTED TYPE. ANY SKETCHES USED ON CONTRACT DRAWINGS SHOULD HAVE NOTE THAT FIXTURES SIMILAR IN DESIGN AND EQUAL IN QUALITY ARE ACCEPTABLE.

FIGURE 10 EXTERIOR LIGHTING FIXTURES

OBSOLETE

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indicated on the electrical site plan so as to call to the contractor's attention that portion of the work which will be performed by others during the course of his contract and work.

b. Telephone System. The local telephone company should be consulted before preparation of plans showing telephone facilities, so that their experience may be used, to obtain the most economical layout. The service of their engineers is available without cost, for consultation and advice, in all matters pertaining to telephone systems for projects.

The probable demand for a project will determine the facilities to be provided at a minimum cost. The numbers of installations in existing projects vary from 2 to 55 per cent of the number of dwelling units.

Site facilities for a telephone system depend, to a large extent, on the method of electrical distribution for lighting and power. Where a project-owned overhead electrical distribution is planned, telephone lines generally can be brought from outside the property line to the various buildings on project-owned poles. However, if certain electrical characteristics of the distribution system are not satisfactory to the telephone company for an installation of their facilities on project-owned poles, the telephone company will furnish and install their own pole structures.

Where an underground electrical distribution is to be installed, provision should be made for underground distribution of telephone cables. This should consist of underground ducts, or trenches only (for direct earth buried cable), for connecting buildings and main service to the property.

c. Public Telephones. Provision should be made for pay telephone stations on a project, unless convenient public telephone facilities are available close to a relatively small project. Generally, provision should be made for one or more public pay telephone stations, depending on the size of the project.

This schedule is based on underground distribution system serving dwelling units with LIGHTING, REFRIGERATION AND RANGES. Project lighting included, but not project power.

Number of D.U.	KW Per D.U.	Total KW	Amp. at 230 V. 3 wire 1 phase	Amp. at 208 V. 3 phase 4 wire
1	4.00	4.0	17.4	11.3
2	3.65	7.3	31.7	20.2
3	3.30	9.9	43.0	27.5
4	3.20	12.8	55.8	35.6
5	3.20	16.0	70.0	44.5
6	3.20	19.2	83.6	53.5
7	3.00	21.0	91.5	58.4
8	2.80	22.4	97.9	62.4
9	2.70	24.3	106.0	67.6
10	2.60	26.0	113.0	72.2
11	2.50	27.5	119.0	76.3
12	2.45	29.4	128.0	81.6
13	2.40	31.2	135.7	86.6
14	2.35	32.9	143.0	91.3
15	2.30	34.5	150.0	95.8
16	2.25	36.0	157.0	100.0
17	2.20	37.4	163.0	103.8
18	2.15	38.7	168.0	107.5
19	2.10	39.9	173.0	110.8
20	2.05	41.0	178.0	113.8
21	2.00	42.0	182.5	116.6
22	1.95	42.9	187.0	119.1
23	1.90	43.6	190.0	121.1
24	1.85	44.5	193.0	123.6
25	1.80	45.0	196.5	125.0
26	1.75	45.5	197.5	126.3
27	1.70	45.9	199.0	127.5
28	1.65	46.3	201.0	128.6
29	1.63	47.3	203.0	131.3
30	1.62	48.0	212.0	135.5
31	1.60	49.5	219.5	137.5
32	1.59	50.9	221.0	141.3
33	1.58	52.3	227.0	145.05
34	1.57	53.4	232.0	148.3
35	1.56	54.6	238.0	151.6
36	1.55	55.9	243.0	155.4
37	1.54	57.1	249.0	158.6
38	1.53	58.2	253.0	161.8
39	1.52	59.4	258.0	165.0
40	1.51	60.5	263.0	168.05
41	1.50	61.5	267.5	170.8
42	1.49	62.6	272.0	173.0
43	1.48	63.8	277.5	177.2
44	1.47	64.7	282.0	180.2
45	1.46	66.0	287.0	183.2
46	1.45	66.8	291.0	185.5
47	1.44	67.7	294.0	188.05
48	1.43	68.6	298.0	190.05
49	1.42	69.4	302.5	192.7
50	1.41	70.5	306.0	195.2
51	1.40	71.4	310.4	198.3
52	1.40	72.8	316.5	202.2
53	1.40	74.2	322.6	206.0
54	1.40	75.6	328.7	210.0
55	1.40	77.0	334.8	213.9
56	1.40	78.4	341.0	217.8
57	1.40	79.8	347.0	221.7
58	1.40	81.2	353.0	225.5
59	1.40	82.6	359.0	229.4
60	1.40	84.0	365.0	233.3

Number or D.U.	KW per D.U.	Total KW	Amp. at 230 V. 3 wire 1 phase	Amp. at 208 V. 3 phase 4 wire
61	1.40	85.4	371.3	237.2
62	1.40	86.8	377.0	241.1
63	1.40	88.2	383.4	245.0
64	1.40	89.6	389.6	248.9
65	1.40	91.0	395.7	252.7
66	1.40	92.4	401.7	257.0
67	1.40	93.8	407.8	260.5
68	1.40	95.2	413.9	264.5
69	1.40	96.6	420.0	268.5
70	1.40	98.0	426.0	272.2
71	1.40	99.4	432.0	276.0
72	1.40	100.8	438.0	280.0
73	1.40	102.2	444.5	284.1
74	1.40	103.6	450.4	287.8
75	1.40	105.0	456.5	291.8
76	1.40	106.4	462.6	295.5
77	1.40	107.8	468.6	299.5
78	1.40	109.2	474.7	303.5
79	1.40	110.6	480.8	307.6
80	1.40	112.0	486.9	311.0
81	1.40	113.4	493.0	315.0
82	1.40	114.8	499.0	318.8
83	1.40	116.2	505.0	322.7
84	1.40	117.6	511.0	326.8
85	1.40	119.0	517.0	330.5
86	1.40	120.4	523.4	334.5
87	1.40	121.8	529.5	338.5
88	1.40	123.2	535.6	342.2
89	1.40	124.6	541.7	346.0
90	1.40	126.0	547.8	350.0
91	1.40	127.4	553.9	353.8
92	1.40	128.8	560.0	357.8
93	1.40	130.2	566.0	361.9
94	1.40	131.6	572.0	365.5
95	1.40	133.0	578.0	369.5
96	1.40	134.4	584.0	373.5
97	1.40	135.8	590.4	377.2
98	1.40	137.2	596.5	381.0
99	1.40	138.6	602.6	385.5
100	1.40	140.0	608.6	388.8
101 - 500	1.40	--	--	--
501 - 600	1.30	--	--	--
601 - 800	1.25	--	--	--
801 - 2000	1.20	--	--	--
2001 - 4000	1.10	--	--	--

Note:
1. The above figures are to be used for underground secondary distribution system and are based on the use of the conventional type transformer.
2. For an overhead secondary distribution system and transformers on pole, reduce the figure by 30%.
3. For transformers in well ventilated vaults, reduce the figure by 20%.

EXHIBIT A DEMANDS FOR SIZING FEEDERS & TRANSFORMERS, INCLUDING RANGES

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OBSOLETE

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Bulletin No. LR-8
PART II
Exhibit B

This schedule is based on underground distribution system serving dwelling units with LIGHTING ONLY or with LIGHTING AND REFRIGERATION. Project lighting included but not project power.

	Lighting Only				Lighting and Refrigeration			
Number of D.U.	KW Per D.U.	Total KW	Amps. 230 V. Single Phase	Amps. 208 V. 3 phase 4 wire	KW Per D.U.	Total KW	Amps. 230 V. Single Phase	Amps. 208 V. 3 phase 4 wire
1	.805	.805	3.5	2.24	.955	.955	4.15	2.65
2	.775	1.55	6.74	4.18	.920	1.84	8.00	5.11
3	.745	2.24	9.74	6.22	.885	2.65	11.08	7.25
4	.270	2.88	12.51	8.00	.855	3.42	14.86	9.5
5	.708	3.54	15.40	9.84	.838	4.19	18.2	11.6
6	.698	4.19	18.20	11.63	.823	4.94	21.4	13.7
7	.688	4.81	20.90	13.37	.808	5.65	24.6	15.7
8	.669	5.35	23.22	14.87	.784	6.27	27.2	17.4
9	.660	5.94	25.80	16.50	.770	6.93	30.1	19.2
10	.652	6.52	28.35	18.11	.757	7.57	32.9	21.1
11	.646	7.11	30.95	19.75	.746	8.20	35.6	22.8
12	.638	7.65	33.11	21.21	.735	8.82	38.3	24.5
13	.630	8.20	35.62	22.78	.724	9.40	40.8	26.1
14	.625	8.75	38.00	24.30	.716	10.05	43.6	27.9
15	.620	9.30	40.40	25.80	.708	10.61	46.2	29.5
16	.615	9.85	42.80	27.38	.700	11.20	48.7	31.1
17	.610	10.40	45.20	28.90	.695	11.82	51.4	32.8
18	.605	10.90	47.40	30.25	.690	12.41	54.0	34.5
19	.600	11.40	49.50	31.65	.685	13.00	56.6	36.2
20	.595	11.90	51.70	33.00	.680	13.6	59.1	37.8
21	.590	12.40	53.90	34.40	.675	14.2	61.6	39.4
22	.585	12.90	56.10	35.80	.670	14.75	64.1	41.0
23	.580	13.40	58.20	37.20	.665	15.30	66.5	42.5
24	.576	13.80	60.00	38.15	.660	15.85	68.9	44.0
25	.570	14.25	61.90	39.60	.652	16.3	70.9	45.3
26	.565	14.70	63.90	40.80	.647	16.82	73.2	46.8
27	.560	15.10	65.60	41.90	.642	17.33	75.2	48.1
28	.555	15.50	67.4	43.0	.637	17.83	77.7	49.7
29	.550	15.95	69.4	44.3	.632	18.25	80.0	50.8
30	.545	16.35	71.1	45.4	.624	18.64	81.4	51.2
31	.540	16.75	72.8	46.6	.619	19.18	83.5	53.3
32	.535	17.10	74.3	47.5	.614	19.64	85.3	54.5
33	.530	17.50	76.1	48.6	.609	20.09	87.4	55.7
34	.525	17.85	77.6	49.6	.604	20.53	89.5	57.2
35	.520	18.20	79.1	50.6	.595	20.80	90.7	58.3
36	.515	18.55	80.6	51.5	.590	21.24	92.5	59.1
37	.510	18.90	92.2	52.5	.585	21.64	94.1	60.2
38	.505	19.20	83.4	53.4	.580	22.04	96.0	61.3
39	.500	19.50	84.8	54.2	.575	22.42	97.5	62.4
40	.495	19.80	86.1	55.0	.567	22.68	98.7	63.0
41	.490	20.10	87.4	55.8	.562	23.0	100.00	63.9
42	.485	20.40	88.7	56.6	.557	23.4	101.7	65.0
43	.480	20.60	89.5	57.2	.552	23.85	103.5	66.0
44	.475	20.90	90.8	58.0	.547	24.1	104.8	66.9
45	.470	21.20	92.2	58.9	.539	24.25	105.3	67.4
46	.465	21.40	93.0	59.5	.534	24.6	107.0	68.3
47	.460	21.60	93.9	60.0	.529	24.85	108.0	69.0
48	.455	21.80	94.8	60.5	.524	25.19	109.2	69.9
49	.450	22.10	96.1	61.4	.519	25.41	110.6	70.7
50-100	.435				.500			
101-200	.425				.488			
201-300	.400				.460			
301-600	.350				.408			
601-800	.300				.355			
801-1500	.250				.300			
1501-2000	.225				.270			
2001-4000	.200				.240			

Note:
1. The above figures are to be used for underground secondary distribution system and are based on the use of the conventional type transformer.
2. For overhead secondary distribution system and transformers on poles, reduce the figures by 25%.
3. For transformers in well ventilated vaults, reduce the figure by 15%.

EXHIBIT B DEMANDS FOR SIZING FEEDERS & TRANSFORMERS, EXCLUDING RANGES

ELECTRICAL

PART II - EXTERIOR DISTRIBUTION

1. INTRODUCTION. Selection of the type of exterior distribution system when purchase of electricity is on a wholesale basis (through a master metering system) and when the Local Authority provides the exterior distribution system may differ somewhat from those of an average private housing development (where the distribution system is usually designed and installed by the local utility company).

The systems should be geared to simplicity in design, a special need for economy, safety, efficiency of operation, and customary convenience rather than to luxury use. Nothing that will result in unnecessary expense (initial or operating) should be included, but nothing that is essential to satisfactory long-range use should be omitted. Engineers should have an understanding of the problems inherent in low-rent housing, which often require more than average skill and ingenuity.

Designs based on the minimum requirements of the National Electrical Code and National Electrical Safety Code will meet the fundamental objectives for safety and utilization; essentially they are safe codes, and installations made in accordance with their requirements as they pertain to the various functions will be safe when properly maintained and not abused. This does not preclude compliance with requirements of local municipal, State regulatory board or local utility when such requirements are mandatory within a locality.

2. PLANNING CONSIDERATIONS

a. General. The load characteristic of equipment to be served by electric energy is an important factor in the intelligent design of a distribution system. A project load consisting of lighting only results in a low load factor. With 100 percent mechanical refrigeration added to the lighting load, the load factor will be higher. The addition of 100 percent electric cooking to lighting and refrigeration will lower the load factor. Since the load factor is the ratio of the average load over a designated period to the peak load occurring in that period, it is important to consider the effect of heavy loadings for short durations caused by the type or types of equipment served.

If the rate classification under which a project will be served contains a penalty for low power factor, consideration should be given to installing

(Cont'd)

NOTE: This Part supersedes Part II of Bulletin No. LR-8 dated 6-15-50. It has been completely revised.

ELECTRICAL

PART II - EXTERIOR DISTRIBUTION

1. INTRODUCTION. Selection of the type of exterior distribution system when purchase of electricity is on a wholesale basis (through a master metering system) and when the Local Authority provides the exterior distribution system may differ somewhat from those of an average private housing development (where the distribution system is usually designed and installed by the local utility company).

The systems should be geared to simplicity in design, a special need for economy, safety, efficiency of operation, and customary convenience rather than to luxury use. Nothing that will result in unnecessary expense (initial or operating) should be included, but nothing that is essential to satisfactory long-range use should be omitted. Engineers should have an understanding of the problems inherent in low-rent housing, which often require more than average skill and ingenuity.

Designs based on the minimum requirements of the National Electrical Code and National Electrical Safety Code will meet the fundamental objectives for safety and utilization; essentially they are safe codes, and installations made in accordance with their requirements as they pertain to the various functions will be safe when properly maintained and not abused. This does not preclude compliance with requirements of local municipal, State regulatory board or local utility when such requirements are mandatory within a locality.

2. PLANNING CONSIDERATIONS

a. General. The load characteristic of equipment to be served by electric energy is an important factor in the intelligent design of a distribution system. A project load consisting of lighting only results in a low load factor. With 100 percent mechanical refrigeration added to the lighting load, the load factor will be higher. The addition of 100 percent electric cooking to lighting and refrigeration will lower the load factor. Since the load factor is the ratio of the average load over a designated period to the peak load occurring in that period, it is important to consider the effect of heavy loadings for short durations caused by the type or types of equipment served.

If the rate classification under which a project will be served contains a penalty for low power factor, consideration should be given to installing

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NOTE: This Part supersedes Part II of Bulletin No. LR-8 dated 6-15-50. It has been completely revised.

Local municipal and/or State codes and regulations

Local utility company's regulations

Any local requirements which appear to be unnecessarily restrictive should be reviewed with the proper authorities in an effort to secure modification and waivers.

Work included which is contrary to rules and regulations (and is not covered by waivers) and which will have to be changed during construction will result in extra expense. Obtain approval of the final layout from the local and State organizations which have jurisdiction, before bids are taken.

(1) Selection of System. While there is no question that underground utility systems contribute much to the appearance of a development, nevertheless this consideration cannot stand alone in the choice of a distribution system. Utility companies report[1] that underground systems cost approximately 50 percent more than overhead systems (new procedures and products can result in reduced costs). Economics must be a prime factor in determining the type of distribution system to be designed and must influence the final decision. In general, an underground system can seldom be justified in low density design, while in a high density design certain factors may enter the picture which will justify an underground system. Under certain conditions a section of the system may be underground, combined with an overhead portion; for instance an overhead primary with underground transformer stations and underground secondary conductors or the reverse thereof.

Many local utility companies have arrangements for contributions to reduce the cost of distributions systems. The LHA and its architects are urged to consult with the company with the idea of inducing it to furnish underground systems at costs favorably comparable to overhead systems. In every case the company should be consulted as to costs and its experience could influence the final decision.

Some of the important factors which affect the selection of an overhead or underground distribution system are:

(a) Type of existing systems serving areas surrounding the project and the trend in replacement of such systems.

(b) Contour of the project area and ground water level; extent of interference by trees and playgrounds.

(c) Safety factor, depending upon location and voltage of overhead primary lines.

(d) Severity and frequency of electric storms, sleet, ice formations, and wind velocities.

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1/ "Distribution Progress" - Electrical World, November 16, 1964, page 104.

(e) Soil conditions: The presence of rock will increase cost of underground work; soil of low bearing value and high water content may cause difficulties with underground transformer vaults and manholes.

(f) Comparative costs: An underground system will cost more per linear foot than an overhead system. However, the site plan may lend itself to a comparatively short underground system in contrast to a longer overhead system, thereby allowing favorable consideration of the use of an underground system.

(2) Type of Primary Circuit. The simplest form of primary distribution is the radial type, which is considered most practical for low-rent housing. Although it may lack flexibility and does not offer insurance of complete service continuity, it should be given first consideration where topography and arrangement of load are advantageous. Arrangement should be made to install a disconnecting switch to isolate any branch when trouble occurs in that line.

A single "ring" or loop system offers more flexibility than the radial system with a certain degree of flexibility. The single loop, with means for disconnecting the loop at its midpoint, has the advantage of providing a certain continuity of service to all areas, but will be slightly higher in cost than the radial system.

The more elaborate loop system, with sectionalizing switches or disconnecting potheads at each transformer station which allows by-passing of the station or feeding from either side of a loop, has definite advantages where a line break even of short duration may result in accident or loss of life. The cost, as a rule, prohibits such an installation in low-rent housing.

Where conditions permit, a modification incorporating the radial and loop can be applied to meet local conditions and requirements.

(3) Feeder and Transformer Sizing. For estimating the demand of lighting; lighting and refrigeration; and lighting, refrigeration, and cooking--for use in sizing of "outside" distribution feeders (excluding underground secondaries) and capacities of transformer serving dwelling units only--see Exhibit 1. Demands should be increased for the following functions:

(a) Standard domestic water heater - add .75KW per dwelling unit.

(b) High wattage domestic water heater - add 1.25 KW per dwelling unit.

(c) Individual space heating equipment with blower - add .17 KW per dwelling unit.

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(d) Electric space heating - add 60 to 70% of total connected load. Consult with utility company for use factor in the locality.

(e) Air cooling (window or wall units) when there is no electric space heating - add 1 KW per air cooling unit.

These data are based on national averages and should be used with discretion in application to specific local conditions (secondary feeders for underground distribution should be sized in accordance with National Electric Code Article 220).

In estimating demands for project light and power, consult with utility company for use factor as approved for the locality.

Design the system with a minimum of transformer and cable sizes to obtain the lowest possible initial cost and to simplify maintenance and replacements. The ideal condition is one in which all are of the same size.

For exterior distribution, the voltage drop between (1) transformer secondary and service contact at building, and (2) transformer secondary and farthest project area light fixture, should not be more than 5 percent based on demands shown in Exhibit 1.

(4) <u>Local Utility Hook-Up</u>. Points of contact with the utility company lines are to be determined on the basis of negotiations with the company. The most common practice is a single point of contact with electric service metered through a master meter at this point. Several points of contact, each with a master meter, will contribute to lowering distribution and maintenance costs. Permission for totalizing the readings of the watt-hour meters should be obtained from the utility company so that the total consumption may be billed at the lowest possible rate classification.

Where a choice is possible and extended rates permit, the delivered primary voltage should not exceed 4.16 KV and should consist of 4 wire and "Y" connected. This permits the use of nominal 2400 volt apparatus. Distribution of primary service within a project should not exceed 4.16 KV since danger and hazard in operation increase as the primary voltage is raised.

On an overhead 4 wire primary (4160 volts) it is frequently the practice to use a common neutral for the secondary and primary systems. This eliminates one wire and is therefore economical. Ascertain from the utility company if the neutral conductor may be required to take a phase potential, which would necessitate an insulated neutral on the project distribution system. In grounding the system, avoid inductive effects of current flowing to the ground, which may cause trouble in communication lines.

Incoming high tension lines and master metering equipment should be located in or near the maintenance shops or boiler plant, where practical.

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c. Overhead Distribution. The overhead method of distribution may be accomplished by means of: (1) stringing secondary conductors on pole structures and extending service conductors to buildings or (2) extending underground service conductors to first building and stringing conductors on the building structures, looping from building to building. This latter may also permit extending the primary conductors to vault(s) located at end of first building, extending exposed service from this point.

(1) Poles and Lines. It is most desirable to limit pole spacing to 125 feet. By placing transformer stations in the center of loads, the secondary lines will generally result in economical sizes and the length of runs from the transformer station in any direction will not be excessive. Secondary runs which exceed 400 feet in length are considered uneconomical.

When loads imposed on poles are greater than can safely be supported (unbalanced conductors, stresses at angles and dead ends) additional strength should be provided by the use of guys.

Stresses due to line angles between 10 and 60 degrees should be supported by a single guy placed to split the resultant load. Angles greater than 60 degrees should be guyed in both directions.

The extent of guying required should be kept to a minimum by avoiding needless changes in direction. Guys should be so located as not to obstruct walkways, play areas, parking areas, etc., or to interfere with the trees. Avoid slack spanning of wires between poles.

Clearance of service drop conductors over roadways, walks, lots, and buildings should conform to the requirements of the governing boards.

Use bare conductors for voltages above 600 volts where practical, and insulated conductors for voltages under 600 volts. In heavy loading districts a conductor smaller than No. 6 medium hard drawn is not recommended. No. 8 may be used in medium loading districts on short spans only. Secondary conductors larger than No. 2/0 are not recommended as they are difficult to handle on overhead construction.

(2) Secondary Distribution on Buildings. Where the arrangement and types of buildings permit, the stringing of the secondary along buildings rather than on poles will eliminate some poles. This method is not recommended where buildings are less than two stories in height.

The secondary cable should be of the standard 3 or 4 conductor (as required) concentric "service entrance" type, extended from the transformer location (building with vault, or pole) to the building and run along buildings (close to roof line) spanning from one building to another. At span supports (on poles or buildings) use "concentric service cable clamps" to provide proper grip of cables.

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At each point of tap along the building install a rigid rust-proof "service connection box." In this connection box the concentric neutral should be opened and properly formed; the phase conductors should be tapped by means of screws puncturing the insulation, creating a pressure contact between line conductor and tap. From the connection box the service tap should extend to the metering and/or protective equipment.

(3) Transformer Stations. Transformation should be in one step, to reduce core and copper losses and switching equipment costs. Transformer stations should be placed at center of load. Balance the load on each of the primary phases.

Study the comparative cost of the completely self-protected type of transformer with internal secondary circuit breaker protection and the conventional transformer with separate externally-mounted primary protective and disconnecting devices since the selection may affect the size of transformers. (A study of the lighting, refrigeration, and cooking loads on existing projects indicates that the most serious overload condition is encountered during the one-hour period after the transformers have begun to operate at full load.)

d. Underground Distribution. Routing of underground raceways should be related to the contour of the finished site. Profiles should be developed to show elevations between vaults, manholes, and buildings--and the location of service sleeves in buildings. Working drawings should indicate the elevations for proper installation.

Raceways, vaults, and manholes should be arranged to prevent the accumulation of subsurface and surface water.

The following methods of underground installation have proved satisfactory. Choose that which is best adapted to the project design and lowest in initial and maintenance costs.

(1) Metal raceway - encased in concrete.

(2) Non-metallic raceway - encased in concrete.

(3) Non-metallic raceway - buried directly in earth.

(4) Cable - buried directly in earth.

Raceways should be installed with a slope of not less than 6 inches for each 100 linear feet of raceway and sloped toward manholes. Access covers of manholes and/or underground vaults should be raised above surrounding grades so that surface water will run away from openings. French drains and rock bed drains should be used only where soil conditions permit quick absorption of water.

Where the underground cable enters a building through a conduit sleeve or where the underground duct and/or conduit terminates in a junction box on the inside of a building, the open space between the cable and the conduit or sleeve should be sealed at the point of entry or in the junction box (with a suitable sealing compound) to prevent the infiltration of any outside gases into the building (through the underground distribution system).

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(1) Primary Cable. Lead-covered and non-leaded covered cables have both proved satisfactory generally for underground installations except in some coastal areas where chemical action has eaten through the lead sheath within a period of three to five years. Under reasonably normal conditions the life of cable is conservatively estimated as being about 50 years. When consideration is given to the use of non-leaded cable great care should be exercised in the selection of the type and grade, particularly when buried directly in earth.

(2) Secondary Cable (voltages up to 600). Secondary conductors specially designed for direct burial in earth under various soil conditions have been in use for a number of years on a relatively large scale, and experience with this type of cable has been generally satisfactory. It is easier to handle and terminate and appreciably less expensive than leaded cable. Because of the problems inherent with soil conditions and resulting corrosion, only non-metallic cables should be used for direct burial.

(3) Transformer Stations. A comparative study should be made covering the cost of placing transformers in: (1) vaults within buildings; (2) underground vaults independent of buildings; (3) vaults or kiosks above grade; and (4) metal clad enclosures and transformers on a concrete pad on grade. Kiosks could be developed in conjunction with comfort stations, tool sheds, or telephone booths. Underground vaults which are independent of buildings require subway type transformers and equipment costing more than standard equipment. Vaults within buildings or kiosks above grade will use standard equipment and offer greater accessibility with less expensive servicing and maintenance.

In recent years the metal enclosure and transformer on a concrete pad on grade has gained favor in large housing developments because it eliminates unsightly pole lines, reducing installation costs and simplifies inspection and repairs. Shrubs and/or bushes should be installed around the station to hide its location. In addition, consideration should also be given to providing a protecting fence enclosure to prevent access to station by unauthorized persons.

Transformer vaults should contain the transformers and disconnecting means only and should not be accessible to any unauthorized person(s). Design should provide adequate clearance around equipment, proper ventilation, fire protection, required grounding, and shall meet the requirements of the National Electrical Code and the National Board of Fire Underwriters.

Consider the use of 3-phase transformer units in lieu of three single-phase units, in view of: (1) occupying less floor space, (2) less over-all weight, (3) lower core losses, (4) one unit to handle and correct, (5) lower initial cost. Overhead bus and bus supports may be eliminated where the transformer primary bushings (3-phase unit) are taken through the side of the transformer, provided a steel box is welded on the tank and the box contains oil cutouts.

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Doors and openings to vaults and manholes should be large enough to permit removing or replacing equipment. Consult with the local utility company for other requirements. Foreign pipes and ducts should not be installed within switch-rooms or transformer vaults.

The use of oil fuse cutouts for short circuits and overload protection on each phase provides a simple and rugged primary disconnecting means. These cutouts are available for gang operations when load-break is desired. At a slight increase in cost the operating lever can be extended to be operable from outside the vault through a small wall opening approximately 10"x18". Provide hinged steel cover with lock for emergency operation.

When cutouts other than the oil fuse type are to be used they should have isolating disconnect switches to permit replacing blown fuses without undue hazard. This arrangement requires added equipment and needs more space.

When single conductor leaded primary feeders terminate within a vault the conductors should be carried direct to the wiping sleeve on the oil fuse cutout, thereby eliminating the use of a terminating pothead within the vault. The use of 3-conductor leaded primary cables requires the installation of a through type indoor pothead at the cable entrance. Disconnecting potheads should not be used since they present an operating hazard.

"Load center power units" of capacities ranging from 50 to 150 KVA are also available for transforming electrical energy. The unit is factory assembled and shipped from the manufacturer as a complete metal enclosed load center unit, consisting of high voltage protection, meter transformer space, transformation, and low voltage protection. The only field connections required are to the primary supply and secondary distribution feeders. These "power units" are for use on single- or three-phase systems.

Underground distribution centers should be avoided. When required, they should be provided with links or solid connections. Fuse protection should not be used in this equipment.

e. Illumination. In illuminating a site, consideration must be given to the lowest practical initial cost consistent with low maintenance and operation without jeopardizing safety to human life. Many individual factors must be considered in establishing the requirements for lighting a site, and each must be weighed according to its importance. Proper illumination is important; it should not be passed over lightly. The services of an illumination engineer should be utilized. (The utility company may render this service at no cost to the project.)

(1) Objectives. Proper site illumination promotes nighttime safety and convenience of persons on the project and will reduce vandalism and delinquency actions. It should protect all persons by enabling them to discern any other person walking or lurking about the premises. It is important that the faces and features of persons passing by should be recognizable at close range.

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Personal safety should be assured by a lighting system which will enable a person to see any obstruction in his path and all irregularities such as depressions, unevenness, stairs, excessive slopes, etc.

(2) Visibility. Objects at night are seen by silhouette, by contrast, and to a lesser extent by their brightness. It is desirable to place lighting units close to sidewalks (as high as practical) and to other light-colored backgrounds rather than, for example, in the center of dark grass plots. Location of the units along the walk, where possible, will also throw direct light upon pedestrians.

(3) Intensity. High intensities of light are not necessary to show contrasts or silhouettes but are desirable to obtain as uniform a distribution as possible. Since light varies inversely as the square of the distance, a reflecting medium projecting much of the light away from its source is sometimes used effectively.

(4) Glare causes a decrease in the ability of the eye to see, and should, therefore, be eliminated as far as possible. Where glare is present more light is necessary for the same visibility than where it is absent.

The higher the light source above eye level, the less the glare. When glare is considered as 1 at 32 feet mounting height, it increases to 8.4 at 12 feet mounting height.

Glare may be controlled by proper reflectors covering the lamp and distributing the light by controlled reflection since it is caused by intrinsic brightness of the unit. Reflectors should be designed to deflect the light beam from windows of dwelling units to avoid annoyance to tenants.

(5) Area Lighting. Locate lighting units with relation to planting, building arrangements, building heights, walks and steps, parking areas, sitting areas, small children's play areas, contour of site, and existing and proposed street lighting. Proper coordination of layouts should reduce some of the problems that have plagued some localities.

The effect of trees and their interference with the distribution of light should be considered carefully in laying out area lighting. Units should be so placed that trees will not cause shadows over large areas. In the interest of safety, place a light source at steps and along walks to allow direct illumination from the light units.

Building arrangements and their heights will govern the spacing and mounting heights of light sources. The higher the mounting height, the broader the light distribution. The mounting height should be related to building height, for example, two-story buildings may permit 18-foot mounting heights, whereas one-story buildings need mounting heights of 12 to 15 feet for pleasing appearance.

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Site contours should be studied; a sloping site generally requires a larger number of light units than a flat site covering the same area. Spacing of units is important to obtain uniform distribution. To obtain uniformity, spacing between units should not exceed 8-10 times the mounting height of center of light source. When appearance demands low mounting height, closer spacing is necessary.

Any illumination of perimeter and through streets should be taken into account in placing lighting units. Where existing street lighting is inadequate, confer with the city officials to secure proper illumination. All street lighting on public streets within or bordering the project should be provided and maintained by the local municipality.

(a) Types. Stock designs of good quality are not expensive and should ultimately result in lowest overall costs--maintenance and replacements. Where the local municipality has adopted certain types of fixtures as standard, such types may be adopted for the project particularly if project streets are to be dedicated to the city and/or advantage can be obtained through buying power of the municipality.

Lighting units may be in the form of standards with enclosing globe luminaries mounted on top or metal hood and enclosing globe on brackets or extended arms, bracket type fixtures--metal hood and enclosing globe, open reflectors, industrial type--for mounting on project poles or fixture mounted on buildings. The selection as to type depends upon the form of electrical distribution (overhead or underground) and on the types and heights of buildings. Initial and total overall operating cost should always be considered in determining the method of lighting. Mercury vapor lamps should be considered, as they are proving satisfactory and economical.

Uniformity of light distribution is dependent upon the design and shape of the reflector. Uniformity of lighting will be further accomplished by higher mounting of lighting units, about 24-30 feet. In general, light fixtures should be of a design that would produce a minimum foot-candle of illumination--at a longitudinal distance of 4 times the height of light source--not less than 1/4 the average foot-candles for the distance, or a design minimum of 0.10 foot candles.

Since outdoor equipment is subject to rough usage and abuse, non-breakable equipment should be selected with the lamps protected by some form of break-resistant covering. Where need is paramount, fixtures should be equipped with suitable guards.

Posts for lighting standards are available in steel, concrete, aluminum, or wood. Wood posts cost less but have a shorter life than steel or concrete posts. Concrete posts as used by some municipalities for street lighting have been in use in some projects. They look well in yards of large housing projects and require practically no maintenance. Steel posts are considered equally satisfactory though periodic painting is required. Where short post lights up to 12 feet high are used with incandescent lamps, shock absorbing sockets should be used to prevent lamp filament breakage from blows on posts.

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A handhole with a locking cover should be provided at base of each standard for access to the connection between underground wiring and standard wiring.

(b) Control. Control the circuits feeding the area yard lighting through use of time-clock(s) or photo-electric unit(s) for operation of conductors controlling the lighting circuits. Control should provide for sunset to sunrise operation of circuits. Lighting units with integral photo-electric units will provide automatic control without the need of time-clocks.

(6) Play Area Lighting. The extent of illumination required for play areas should be discussed with local recreational authorities. Floodlights, if used, should be mounted on plain tubular poles or on adjacent buildings, and should be connected to project circuits with provision for separate metering and control. When floodlights are to be furnished by the local recreational authorities, provision of raceways and installation of cables, fixtures, etc., should be adequate.

(7) Obstruction Lighting. It may be necessary to illuminate a high chimney or other obstruction in the path of air traffic. In such cases the Civil Aeronautics Authority, Washington, D. C. 20428, should be consulted and their approval obtained on the proposed layout and equipment.

f. Signalling and Communication.

(1) Fire and Police Alarms. Consult with the appropriate city officials with regard to municipal fire and police alarm systems. The local municipality should provide and maintain new stations, relocate existing stations, and reroute or extend overhead or underground lines in connection therewith as required for a project.

This work as required should be performed in cooperation with the general construction contractor's work. All work to be done by the city should be indicated on the electrical site plan so as to call to the contractor's attention that portion of the work which will be performed by others during the course of his contract and work.

(2) Telephone System. The local telephone company should be consulted before preparation of plans showing telephone facilities so that their experience may be used to obtain the most economical layout. The service of their engineers is available without cost, for consultation and advice in all matters pertaining to telephone systems for projects.

As the demand of a project will average more than 50 percent, it is recommended that telephone facilities be planned for 100 percent saturation.

Site facilities for a telephone system depend to a large extent on the method of electrical distribution for lighting and power. Where a project-owned overhead electrical distribution is planned, telephone lines generally can be brought from outside the property line to the various buildings on project-owned poles. However, if certain electrical characteristics of the

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distribution system are not satisfactory on project-owned poles, the telephone company will furnish and install their own pole structures.

Where an underground electrical distribution is to be installed, provision should be made for underground distribution of telephone cables. In general, this should consist of a sleeve or sleeves through exterior wall of the various buildings so that buried cable can be brought to the building in a trench. Where soil or other special conditions require the use of underground ducts, these should be provided for telephone cable use.

(3) Public Telephones. Provision should be made for pay telephone stations on a project unless convenient public telephone facilities are available close to a relatively small project. Generally, provision should be made for one or more public pay telephone stations, depending on the size of the project.

(4) Television System. When a master T.V. antenna system is to be provided for low-rise structures, the distribution from master antenna equipment location to the dwellings should follow the same pattern of distribution as the light and power distribution. Consult with the local telephone company for recommended clearance between T.V. and telephone distribution.

DEMANDS FOR SIZING FEEDERS AND TRANSFORMERS

This schedule is based on overhead distribution system serving dwelling units with LIGHTING, REFRIGERATION, AND RANGES. Project lighting included, but not project power, water heating, and individual space heating blower

LIGHTING, REFRIGERATION, AND RANGES

Number of D.U.	KW Per D.U.	Total KW	Amp. 230 V. 3 wire 1 phase	Amp. 208 V. 3 phase 4 wire
1	4.00	4.0	17.4	11.3
2	3.65	7.3	31.7	20.2
3	3.30	9.9	43.0	27.5
4	3.20	12.8	55.8	35.6
5	3.20	16.0	70.0	44.5
6	3.20	19.2	83.6	53.5
7	3.00	21.0	91.5	58.4
8	2.80	22.4	97.9	62.4
9	2.70	24.3	106.0	67.6
10	2.60	26.0	113.0	72.2
11	2.50	27.5	119.0	76.3
12	2.45	29.4	128.0	81.6
13	2.40	31.2	135.7	86.6
14	2.35	32.9	143.0	91.3
15	2.30	34.5	150.0	95.8
16	2.25	36.0	157.0	100.0
17	2.20	37.4	163.0	103.8
18	2.15	38.7	168.0	107.5
19	2.10	39.9	173.0	110.8
20	2.05	41.0	178.0	113.8
21	2.00	42.0	182.5	116.6
22	1.95	42.9	187.0	119.1
23	1.90	43.6	190.0	121.1
24	1.85	44.5	193.0	123.6
25	1.80	45.0	196.5	125.0
26	1.75	45.5	197.5	126.3
27	1.70	45.9	199.0	127.5
28	1.65	46.3	201.0	128.6
29	1.63	47.3	203.0	131.3
30	1.62	48.0	212.0	135.5
31	1.60	49.5	219.5	137.5
32	1.59	50.9	221.0	141.3
33	1.58	52.3	227.0	145.05
34	1.57	53.4	232.0	148.3
35	1.56	54.6	238.0	151.6
36	1.55	55.9	243.0	155.4
37	1.54	57.1	249.0	158.6
38	1.53	58.2	253.0	161.8
39	1.52	59.4	258.0	165.0
40	1.51	60.5	263.0	168.05
41	1.50	61.5	267.5	170.8
42	1.49	62.6	272.0	173.0
43	1.48	63.8	277.5	177.2
44	1.47	64.7	282.0	180.2
45	1.46	66.0	287.0	183.2
46	1.45	66.8	291.0	185.5
47	1.44	67.7	294.0	188.05
48	1.43	68.6	298.0	190.05
49	1.42	69.4	302.5	192.7
50	1.41	70.5	306.0	195.2
51-500	1.40			
501-600	1.30			
601-800	1.25			
801-2000	1.20			
2001-4000	1.10			

LIGHTING OR LIGHTING AND REFRIGERATION

Number of D.U.	KW per D.U.	Total KW	Amp. 230 V. single phase	Amp. 208 V. 3 phase 4 wire
1	.955	.955	4.15	2.65
2	.920	1.84	8.00	5.11
3	.885	2.65	11.08	7.25
4	.855	3.42	14.86	9.5
5	.838	4.19	18.2	11.6
6	.823	4.94	21.4	13.7
7	.808	5.65	24.6	15.7
8	.784	6.27	27.2	17.4
9	.770	6.93	30.1	19.2
10	.757	7.57	32.9	21.1
11	.746	8.20	35.6	22.8
12	.735	8.82	38.3	24.5
13	.724	9.40	40.8	26.1
14	.716	10.05	43.6	27.9
15	.708	10.61	46.2	29.5
16	.700	11.20	48.7	31.1
17	.695	11.82	51.4	32.8
18	.690	12.41	54.0	34.5
19	.685	13.00	56.6	36.2
20	.680	13.6	59.1	37.8
21	.675	14.2	61.6	39.4
22	.670	14.75	64.1	41.0
23	.665	15.30	66.5	42.5
24	.660	15.85	68.9	44.0
25	.652	16.3	70.9	45.3
26	.647	16.82	73.2	46.8
27	.642	17.33	75.2	48.1
28	.637	17.83	77.7	49.7
29	.632	18.25	80.0	50.8
30	.624	18.64	81.4	51.2
31	.619	19.18	83.5	53.3
32	.614	19.64	85.3	54.5
33	.609	20.09	87.4	55.7
34	.604	20.53	89.5	57.2
35	.595	20.80	90.7	58.3
36	.590	21.24	92.5	59.1
37	.585	21.64	94.1	60.2
38	.580	22.04	96.0	61.3
39	.575	22.42	97.5	62.4
40	.567	22.68	98.7	63.0
41	.562	23.0	100.00	63.9
42	.557	23.4	101.7	65.0
43	.552	23.85	103.5	66.0
44	.547	24.1	104.8	66.9
45	.539	24.25	105.3	67.4
46	.534	24.6	107.0	68.3
47	.529	24.85	108.0	69.0
48	.524	25.19	109.2	69.9
49	.519	25.41	110.6	70.7
50-100	.500			
101-200	.488			
201-300	.460			
301-600	.408			
601-800	.355			
801-1500	.300			
1501-2000	.270			
2001-4000	.240			

NOTE:

1. The above figures are to be used for overhead secondary distribution system and are based on the use of the conventional type transformer.
2. For underground secondary distribution system use NEC method for calculating demand and feeder size.
3. For transformers in well ventilated vaults, increase the figure by 15%.