VERTICAL TRANSPORTATION ENGINEERING GUIDE

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1.0 INTRODUCTION

1.01 In the design of a telephone building, elevator requirements vary from one elevator to satisfy minimum demand for elevator service in low-rise buildings to major installations in high-rise buildings without which the building could not function. Failure to provide adequate vertical transportation for personnel and materials, particularly in large equipment and office buildings, proves costly in terms of operating efficiency and time wasted waiting for elevator service. Similarly, providing equipment in excess of requirements is a needless expenditure of money and a costly waste of space. When elevator service is to be provided, it should be designed to furnish good service. A criterion commonly used today is this: The number and speed of the cars is such that the average waiting time for an elevator does not exceed thirty seconds. In the case of a fairly large building, there may be several solutions which meet the requirement. Cost will be an important factor in selecting the equipment to be used.

1.02 It appears to be the consensus that it is desirable to provide elevator service in telephone equipment buildings and other telephone buildings more than three stories high and in three story telephone equipment buildings when the operating room is on the third floor. This is not a rule to be applied rigidly. There may be valid and sufficient reason for not providing elevator service for certain buildings which fall in these categories. And there may be other cases where it is wise to consider providing elevator service for three story buildings — for example — a three story accounting building where cafeteria facilities are located in the basement.

1.03 The number, size and speed of elevators in low-rise equipment buildings (up to seven floors) does not usually require a special study since the demand for elevator service rarely exceeds the capability of one or two elevators. Selection of elevators for such buildings is usually left to the Architect's judgement, which is influenced by past experience in similar buildings.

1.04 Selection of vertical transportation equipment in large equipment and/or office buildings (over seven floors) cannot be made on a "rule of thumb" basis. A traffic analysis is necessary to determine the number, size, speed and floors served by the elevators. The analysis is based on the number of floors, floor heights, area of floors, population, etc. The analysis can be made by major elevator companies who provide this service at no charge to the Owner or Architect. However, the results are sometimes suspect on the basis that the elevator company sells the equipment. On large projects it is advisable to have the traffic analysis made by an unbiased engineer, either in the employ of or retained by the Owner or Architect.

2.0 CODES AND REGULATIONS

2.01 Elevator codes govern design, construction and safety requirements pertaining to vertical transportation equipment.

(a) The American National Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks (ANSI-A17.1)* serves as a guide for state and municipal authorities in drafting their regulations for installation and maintenance of this equipment. This Code, originally issued in 1921, has been amended and revised periodically to keep pace with the industry's development of new equipment and experience derived from actual operation of the equipment.

* *Published By The American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.*

(b) Many state and municipal authorities have adopted this Code as their regulation. Others have used this Code as a basis for developing their regulations or have adopted this Code and modified certain sections to suit their particular requirements. Definitions in Section 3 of the ANSI-A17.1-1971 edition of the Code are generally accepted by all authorities and can be used as a reference for definitions in this guide.

(c) Elevator manufacturers abide by the regulations of this Code unless local authorities have more stringent requirements.

2.02 The design and safety requirements for electrical wiring and equipment are governed by electrical codes.

(a) In the absence of more stringent local codes, the State or National Electrical Code should be used as a reference.

2.03 The design and construction of hoistway doors and frames are governed by local Codes. BSP 760-620-150 specifies a "B" Label Door (Underwriters' Laboratories).

2.04 Local Building Codes govern design and construction of shafts, structure, machine rooms and ventilation.

(a) In the absence of more stringent local codes, the National Building Code should be used as a reference.

2.05 Where local, state or OSHA (Occupational Safety and Health Act) regulations require higher degrees of protection, the legislated criteria should be followed. To date OSHA has no requirements pertaining to permanent elevator installations. However, there are requirements for temporary or construction elevators which should be used for reference.

3.0 SELECTION OF PASSENGER ELEVATORS

3.01 The accepted criterion used as the basis for design of a passenger elevator system is the passenger handling capacity or the system's capability of transporting a certain number of persons in a five minute up-peak period and the elevator interval.

3.02 The required handling capacity for a passenger elevator system is determined by establishing the population of the building and, based on data collected in traffic studies of similar buildings, determining the percentage of the population that will demand elevator service during a five minute period. Although the heaviest demand for elevator service occurs at noon when occupants are leaving their work stations for lunch and others are returning, it is impractical to design the elevator system for this demand. This peak demand, which consists of frequent stops by the elevators in both directions of travel, occurs for approximately one hour of the day. The demand during the remainder of the day, including heavy interfloor traffic, will not approach the traffic generated at lunch time. When employees are leaving the building the demand for service is predominantly in the "down" direction. The five minute capacity of the elevators at this time is greater than at any other time of the day due to fully loaded cars bypassing corridor calls and accomplishing a round trip in a much shorter time. The accepted practice, therefore, is to design the elevator system to satisfy a morning up-peak demand when the traffic demand is pre-dominantly in the "up" direction with occasional demand for interfloor service.

(a) The handling capacity of an elevator is determined by calculating the round trip time of an elevator based on average loading, travel, probable number of stops, speed, door time, loading time, etc., and translating this time into the number of passengers each elevator can transport in a five minute period. The factors used in such calculations have been developed from actual traffic studies of buildings by elevator manufacturers, architects and consulting engineers. Details used in such calculations are not usually available to the clients. The major elevator manufacturers have now computerized this information and given the design parameters can quickly develop the elevator requirements for a building. The design parameters required are:

(1) number of floors in the building;

(2) floor heights,

(3) population per floor;

(4) desired five minute handling capacity;

(5) desired elevator interval.

(b) Traffic studies made of telephone buildings indicate that the peak five minute capacity of an elevator system should be based on appproximately 15% of the building population. This factor, until recently, was based on 20% of the population, but due to public transportation congestion, staggered working hours etc., 15% is more realistic. However, for buildings in the suburbs or less congested areas where car pools and individuals' automobiles are used for transportation to the building, consideration should be given to using the 20% factor.

(1) In smaller telephone building handling capacity is not a critical factor since work hours for plant, traffic and office personnel are usually staggered.

(c) Elevator companies base passenger capacity of the elevator cars on 80% of the rated capacity and an average weight of 150 lbs. per person. Traffic studies of various buildings indicate that unless a building is under-elevatored, the average loading during the up-peak period is less than used by elevator companies in their studies. A more realistic loading table for up-peak periods for various size elevator cars follows:

Rated Capacity (lbs.)	Passenger Capacity	Average Loading — Up-Peak
2,500	16	11
3,000	20	14
3,500	23	16
4,000	26	18

(d) In the absence of specific population density, the following usable area should be used in large buildings to establish population data required for the traffic analysis:

(1) 100 sq. ft. per person on typical floors;

(2) 150 to 200 sq. ft. per person for floors designed for private offices;

(3) 80 sq. ft. per person may be used where large clerical areas are located;

(4) The design engineer must obtain an estimate of anticipated population of smaller equipment buildings where the above densities do not apply.

3.03 Section 20.0 is a paper describing a method of determining elevator service requirements. This was originally issued a number of years ago and, while somewhat dated and general in nature, it may be used in the early stages of design. Advancements in the electronics field in the past few years have been incorporated in elevator control systems producing efficiencies which cannot be reflected here. Before a final decision is made, all pertinent data should be reviewed by a competent consultant and/or the leading elevator manufacturers for their professional recommendation.

3.04 The elevator interval which is the elapsed time between dispatching elevators from the main terminal reflects on the time passengers must wait for elevator service. The elevator interval is derived from the elevator round trip time divided by the number of elevators in the bank.

(a) Having established the number of elevators required to satisfy the required five minute handling capacity the elevator interval can be reduced only by increasing the number of elevators in a bank. Economic consideration should govern resorting to this procedure to achieve a desired elevator interval.

(b) In low-rise buildings with a low population density the elevator interval is not as critical a factor as in high-rise buildings. One or two elevators will usually satisfy the passenger and freight traffic demand and it is impractical and uneconomical to increase the number of elevators simply to reduce the elevator interval.

(c) The elevator interval in high-rise buildings should be 25 to 30 seconds. A slight increase, up to 10%, is acceptable in an express or high-rise bank of elevators. The elevator interval should never be less than the time required to load a car at the main terminal. It should be noted that an elevator interval of 25 to 30 seconds represents dispatching time between elevators from the main floor during the up-peak period. When traffic is light, reducing round trip time, elevators are dispatched at more frequent intervals. However, when lunch time traffic occurs the round trip time increases due to the two-way demand for service and directly affects the elevator interval which also increases waiting time at typical floors . At such times waiting time at typical floors could increase by 25% to 30%. A similar condition develops when interfloor traffic is extremely heavy. Waiting time for interfloor traffic can be substantially reduced by specifying elevator operation with a zoning feature.

3.05 In high-rise buildings it is usually necessary to limit the travel of elevators to relieve passengers of excessive traveling time on the elevator and conserve usable space. A proper traffic analysis will determine the number of banks of elevators required in the building and the most efficient transfer floors.

(a) Floors served by elevator banks should be arranged to limit travel time to not more than 150 seconds, which is the limit of tolorance of passenger traveling time.

(b) Arranging the elevators in banks usually conserves usable area by reducing the number of elevator shafts running the full height of the building. The low-rise bank of elevators is usually of a slower rated speed than intermediate or high-rise elevators resulting in lower equipment cost.

(c) The arrangement of elevator banks must also take into consideration interfloor traffic which may be generated by a large department being located on a number of floors of the building. If possible, the bank arrangement should be designed to reduce the necessity of transfer from one bank to another to complete an interfloor trip. This also applies when the building is occupied by more than one large tenant.

3.06 When more than one elevator is provided in the building the elevators should be adjacent to each other to obtain the benefit of group operation. The recommended maximum number of elevators in one line is three. Four or more elevators should be arranged in an alcove with elevators facing each other on opposite sides. With this arrangement the elevator lobby should be about 10 feet wide.

(a) An arrangement where the main floor elevator lobby is also a public corridor should be avoided. If unavoidable, the elevator lobby should be at least 12 feet wide.

(b) Elevator efficiency will be seriously affected by a double lower terminal and should be avoided. A double lower terminal where heavy traffic originates at both levels will add 30 to 45 seconds to elevator round trip time.

(c) All elevators in a bank should not serve basement landings unless special conditions prevail that necessitate such service.

3.07 Centralizing elevators in a building is preferred and the walking distance from the elevators to the farthest point should not exceed 150 feet.

(a) Even though the heaviest traffic when entering or leaving a building may be at one end of the building, a central location of the elevators will facilitate interfloor traffic and result in greater savings in time.

(b) Consideration should be given to installing "convenience" elevators in large equipment buildings where the farthest point from the elevator core exceeds 150 feet. Such elevators should be of passenger type with a rated capacity of not more than 2,500 lbs. (7'0" x 5'0" platform). The speed should be not less than 200 F. P. M. Higher speed should be considered if the height of the building exceeds five floors.

3.08 Location of special areas, such as the cafeteria, large conference rooms or an auditorium, can have an adverse effect on some elevator systems.

(a) In smaller buildings where the more sophisticated elevator operating systems are not required such areas should be located at a terminal landing.

(b) In high-rise buildings for which elevator operation with zoning is specified, locating such areas is not as critical. Elevator operation can be arranged to handle heavy traffic normally generated by such areas.

(c) Basement location for such areas should be avoided in all buildings as it creates a double terminal as previously mentioned in paragraph 3.06(b). If unavoidable, consideration should be given to the use of escalators between the basement and first floor.

3.09 The most efficient type of elevator cars for transporting passengers is wide and shallow. Passenger transfer time is substantially reduced by permitting passengers better access to the car doors. Narrow, deep cars should be avoided as the depth of the car inhibits unloading and frequently requires that someone step out of the car to let others out.

(a) Rated capacities are dictated by Code which specifies the minimum rating based on the clear inside area of the platform. The following can platform sizes are standard for the capacities noted:

2,500 lbs.	–	7'0" x 5'0"
3,000 lbs.	–	7'0" x 5'6"
3,500 lbs.	–	7'0" x 6'2"
4,000 lbs.	–	8'0" x 6'2"

(b) Although the traffic analysis of large equipment and office buildings may indicate that a smaller size and capacity elevator car will satisfy the traffic demand, the car selected should be not less than 3,000 lbs. capacity. This size elevator will provide more comfort for the passengers and will permit incidental use for mail carts, etc. without interfering seriously with passenger traffic.

(c) The car width will determine the permissable width of the doors. The 3'6" wide side sliding center-opening doors can be used with 7'0" wide elevator cars and will permit loading or unloading of two passengers side by side. Increasing the door width for the average passenger type elevator does not improve transfer time, but decreasing the width reduces efficient transfer of passengers. 4'0" wide doors should only be selected for elevators of 4,000 lbs. or greater capacity.

3.10 In buildings where elevators are installed and are to be used by handicapped employees, at least one elevator in each bank should conform to the following:

Doors should have at least 32" minimum clear opening and should have safety edge with sensing device.

Cab size should be minimum of 5' deep by 5'-6" wide.

Controls the top of the control panel should be no more than 4'-6" from floor. Control buttons should have Braille markings adjacent to the buttons.

Floor level elevator floor levels must stop within 1/2" maximum of building floor level.

4.0 SELECTION OF FREIGHT AND SERVICE ELEVATORS

4.01 A freight elevator is described as an elevator with vertical biparting doors. The elevator car is of steel construction with a painted finish. A service elevator is a passenger with side-sliding doors. The elevator car is finished with a material more decorative than a freight elevator but which will withstand abuse from carts, dollies, etc.

4.02 In low-rise buildings it is usually more practical to provide a passenger type elevator to serve as a combination passenger-freight (service) elevator. Freight traffic as such is minimal and a freight type elevator solely for this purpose could not be justified.

(a) Materials, supplies and equipment transported vertically in such buildings are relatively small in size and movement is minimal. The configuration of the elevator car should be wide and shallow which is better suited for passenger traffic.

(b) The elevator should be rated for a capacity of not less than 3,500 lbs. with a 7'0" x 6'2" platform which will accommodate office furniture, supply carts or trucks and most pieces of equipment used in the building.

4.03 Movement of materials, supplies, equipment, etc. in larger office buildings occurs throughout the day. A service elevator should be provided for this purpose on the basis of one service elevator for buildings of 100,000 to 250,000 sq. ft. of rentable area. A ratio of one service elevator for each group of eight elevators can be used as a guide in selection of service elevators in larger buildings.

(a) Service elevators should be rated not less than 4,000 lbs. with narrow deep elevator cars which are better suited for movement of materials. The elevator car should be 6'4" wide x 8'0" deep. The elevator should serve all floors of the building and be located convenient to the loading dock or receiving area. Elevator doors should be two speed side-sliding type, 4'0" wide and not less than 7'0" high.

(b) In smaller buildings where three or four elevators are required, a study should be made to determine if adequate capacity is available in the passenger elevators to permit removal of one elevator from passenger service to serve as a service elevator during certain times of the day.

4.04 Freight type elevators should be provided in large equipment buildings for transporting telephone equipment, construction materials, long lengths of pipe, structural members used in frame assembly, bus bars, etc.

(a) Freight elevators are classified by the ANSI Code depending on the type of loading to which they will be subjected. The classifications are Class A — General Freight Loading, Class B — Motor Vehicle Loading, and Class C — Industrial Truck Loading.

(1) Rated capacity of Class A elevators is based on 50 lbs. per sq. ft. of inside net platform area. One piece loads on this class of elevator are limited to 25% of the rated capacity.

(2) Class B ratings apply to garage type elevators used to carry automobiles and trucks. Loading is based on 30 lbs. per sq. ft. of inside net platform area.

(3) Class C ratings in three classifications, Class C1, C2 and C3, apply to elevators used for industrial truck and heavy concentration loading. Basic load rating is 50 lbs. per sq. ft. but other requirements apply for Class C1 and C2 loading which should be checked with Code requirements.

(4) Class A rating will satisfy freight requirements in most telephone buildings. When elevators of other classes are required it is advisable to consult elevator manufacturers or the Architect for special design details. Local codes should be checked for possible deviation from the ANSI Code for all classes of loading.

(b) At the present time the largest piece of telephone equipment measures approximately 1'6" x 7'6" x 12'0" when crated. This piece of equipment is transported on dollies with the long dimension horizontal. The elevator car must, therefore, be not less than 13'0" deep which would permit loading the dollie perpendicular to the rear wall of the car. In order to permit loading more than one piece of equipment per elevator trip, the elevator trip, the elevator car platform should be 8'4" wide which will provide an 8'0" wide clear opening. Hoistway doors should be 8'6" high, vertical biparting type to accommodate equipment which may be loaded on the car in the vertical position.

(c) Channels used in frame assembly, bus bar, pipe, etc. usually measure 20 feet long. A car platform 18 feet deep with a 10 foot high ceiling is required to permit 20 foot lengths to be loaded in an inclined plane from the bottom front of the car to the top rear. Such material can also be loaded on a 13 feet deep elevator car when pockets 8'4" high are provided on the car enclosure. This arrangement has been successful in many recently constructed buildings.

(d) Freight elevator capacity of 8,000 lbs. should be adequate for transporting telephone equipment. Although Class A loading limits one piece loads to 25% of the rated capacity, experience indicates that 8,000 lb. capacity elevators are presently transporting

ESS Program Stores which weigh 2,500 lbs. with no adverse effects. Power rectifiers which weigh 4,500 lbs. can also be transported by such an elevator provided the elevator is not subjected to such use continuously.

4.05 Freight and service elevators should serve all floors in the building.

5.0 ELEVATOR MACHINES

5.01 The most commonly used elevator driving machines are electric traction type geared or gearless machines. Elevators driven by oil-hydraulic power units are also commonly used for installations of limited travel. Electric drum type machines are not permitted for passenger service and only limited application for freight service and are not recommended for telephone buildings.

5.02 Geared machines consist of a worm and gear speed reducer driven by high speed AC or DC motors. The motor shaft is coupled to the worm shaft which drives the gear. The gear is directly connected to the traction drive sheave by means of a shaft.

(a) Single or two-speed AC motors are used for speeds up to 150 F. P. M.

(b) DC motors are used for speeds of 200 to 350 F. P. M. Elevator manufacturers have limited use of geared machines to a maximum speed of 350 F. P. M. Higher speed geared machines are available from some manufacturers for certain duties. The speed of the motor is controlled by varying the voltage output of the AC-DC generator.

5.03 Gearless machines are slow speed DC motors. The armature shaft of the motor is directly connected to the traction drive sheave. The speed of the motor is controlled by varying the output of the AC-DC generator.

(a) The rated speed of gearless machines ranges from 400 to 1800 F. P. M.

5.04 Oil-hydraulic power units are completely self-contained consisting of an AC motor, oil pump and oil reservoir. The oil is pumped directly into a jack unit which consists of a cylinder and piston. The piston is directly connected to the car platform.

(a) The rated speed of hydraulic elevators ranges from 10 to 200 F. P. M.

(b) The most practical rated speed for a hydraulic passenger or freight elevator is between 90 and 125 F. P. M. Motors for elevators rated higher than 125 F. P. M. become quite large and resulting energy costs should be studies before a higher speed is selected.

(c) Most manufacturers of hydraulic elevators recommend a limit of approximately 40 ft. of travel. The initial and operating costs of a hydraulic elevator are usually lower than electric elevators. However, poor soil conditions (drilling costs) may sometimes reduce or eliminate the initial cost advantage.

5.05 Selection of elevator rated speed is dependent on the distance of elevator travel. An elevator rarely attains full speed on a one floor run.

(a) The higher the rated speed on a geared elevator the better floor-to-floor performance. The brake-to-brake time on a one floor run can vary from 8.0 to 5.5 seconds for 200 to 350 F. P. M. rated speed.

(b) The brake-to-brake time on gearless elevators from 500 F. P. M. and up does not vary appreciably. Acceleration and retardation are controlled by the output of the generator and controlled to avoid discomfort to elevator passengers due to rapid acceleration and retardation. Brake-to-brake time on a one floor run of 4.0 to 4.5 seconds is considered good performance for gearless equipment.

(c) Floor-to-floor performance for hydraulic elevators is usually not as good as electric elevators. This factor is not important when a hydraulic elevator is selected due to the relatively short travel distance of hydraulic elevators.

5.06 The following table may be used as a guide in selecting the rated speed of elevators.

Floors Above Main	Rated Speed
2 – 4	90 to 125 F. P. M. – Hydraulic
2 – 4	200 F. P. M. – Geared
5 – 6	300 F. P. M. – Geared
7 – 8	350 F. P. M. – Geared
9 – 12	500 F. P. M. – Gearless
13 – 20	700 F. P. M. – Gearless
21 – 26	800 F. P. M. – Gearless
27 & up	Special Study

(a) Generally electric traction type elevators are selected for telephone buildings and the number of floors served and the traffic analysis will dictate the rated speed of the elevators.

(b) In certain types of low-rise buildings, particularly suburban office buildings, hydraulic type elevators are usually a better selection due to the lower runby requirements. A hydraulic elevator can be installed within floor heights of 12 feet which eliminates extending the elevator shaft above the main roof. For freight application at a loading dock or receiving area, where service above the first floor is not required, the shaft height can be limited to the second floor.

6.0 ELEVATOR CONTROLS

6.01 The elevator control system governs starting, stopping and leveling of the elevator. AC resistance and DC variable voltage control are the two most commonly used in modern elevators.

(a) With AC resistance control the elevator motor is started across the AC line or through resistance steps. Single or two speed motors are available for electric traction elevators.

(1) In single speed installations, stopping is accomplished by applying the brake at the speed the elevator is traveling when it reaches a landing causing an abrupt stop and variation in leveling from level to plus or minus 2 to 3 inches.

(2) AC control with two speed motors slightly improves starting, stop and leveling particularly if the ratios between full and low speed are 4 to 1. This ratio varies among elevator manufacturers. Stopping is accomplished by applying the brake at the leveling or slow speed. Leveling accuracy of plus or minus 1 inch is possible with two speed motors. This factor may be disadvantageous, particularly if vehicular traffic is anticipated in the building.

(b) Variable voltage control is accomplished by varying the DC output of a motor generator or rectifier to a DC elevator drive motor. Increasing the voltage on the drive motor armature causes the elevator to accelerate up to speed, decreasing the voltage reduces the speed.

(1) The elevator is brought up to speed smoothly due to the torque of a DC motor and retarding the speed smoothly by absorbing the inertia of the moving load through regeneration. The elevator comes to a complete stop before the brake is applied resulting in a smoother accurate stop at the landing. Leveling can be held to plus or minus ¼ inch of the landing.

(2) Some manufacturers have developed solid state power systems eliminating the need for generators. This development is relatively new and has not been evaluated as to its merits. However, it should be given consideration in the near future.

(c) AC resistance control is used in oil-hydraulic elevator installations. A single speed AC motor drives a pump which supplies oil to the jack assembly. Stopping and leveling is accomplished through a series of valves which controls the flow of oil to the jack assembly. Leveling can be held to plus or minus 3/8" of the landing.

6.02 AC resistance control for electric traction elevators is not recommended due to the abrupt starting and stopping and unsatisfactory leveling. When a slow speed elevator, under 200 F. P. M. is required it is advisable to investigate the use of an oil-hydraulic type elevator since acceleration, retardation and leveling are far superior. Variable voltage control should always be specified for speeds of over 200 F. P. M.

7.0 ELEVATOR LAYOUT

7.01 Electric traction machines can be located directly over the elevator shaft or at a lower floor at the sides or rear and immediately adjacent to the elevator shaft.

(a) Overhead location of elevator machines is preferred in most buildings. Initial cost of equipment and maintenance costs are lower than for machine below installations. Elevator reactions are approximately 50% of machine below installations and result in lighter structural supports.

(b) Machine below installations (basement machines) are desirable when the building is designed for vertical expansion, or when a penthouse projecting above the roof line is not desired. The cost to relocate the overhead sheaves and beams is considerably lower than relocating the machine beams, elevator machine and control equipment. Time required to relocate overhead sheaves and beams is also less than an overhead installation.

(1) Machine below installations are available in two types, direct pickup or underslung. In direct pickup the car is lifted at the crosshead. In the underslung arrangement the car is lifted by passing the hoist ropes around sheaves located under the car platform. The direct pickup type requires greater overhead space due to the vertical sheave arrangement necessary to lead the hoist ropes from the car crosshead, to the machine and then to the counterweight and requires a shallower pit. The underslung type requires less overhead space since the sheaves can be horizontally arranged on the sides and rear of the car. The pit depth, however, must be greater to allow for the projection of the lifting sheaves below the car platform. The direct pickup type is recommended due to simpler roping requirements.

7.02 Oil-hydraulic power units can be located in a space adjacent to or remote from the elevator shaft.

(a) When a remote location is selected it should be limited to not more than 50 feet from the elevator shaft due to possibly excessive pressure drop resulting from long oil line runs between the power unit and the jack assembly.

(b) The oil line should be made accessible to permit inspection for leaks. Setting the line in a trench with removable cover plates is recommended for remote power unit locations. If a trench cannot be provided the oil line should be installed in a conduit pitched toward the elevator pit which would permit a leak to be detected by the presence of oil in the pit.

7.03 The arrangement of elevator equipment in a machine room should provide adequate space for service access around all equipment.

(a) Recommended clearances around electrical panels (controllers, selectors and relay panels) is 3 feet at the front, 2 feet at the rear, and 18 inches on one side. Clearances around elevator machines, motor generator sets and governors should be at least 18 inches. Sufficient clearance should be provided to permit removal of the armatures. National and local codes may permit lesser clearances but experience indicates that the recommended clearances are more practical for servicing purposes.

(b) Oil-hydraulic power units can be installed with one end and rear of the unit relatively close to walls. Clearance of 3 feet should be provided at the front of the unit for access to the pump, motor and leveling valves. The other end clearnace will be dictated by the size of the muffler and piping arrangement.

7.04 It is advisable that contract drawings include an elevator machine room layout regardless of the type of equipment selected, taking into account the worst condition to be expected in competitive bidding.

7.05 Code requirements dictate minimum top and bottom elevator clearances. Basically, these clearances are determined by the rated speed of the elevators. Reference to local code and manufacturers' standards are recommended to determine these requirements.

(a) Hoistway clearnaces around the elevator platform are essentially similar for all elevator manufacturers. These clearances vary with the configuration of the elevator car platform and the type of elevator machine. Specific requirements should be developed by the Architect based on data he obtains from elevator manufacturers or the consultant.

7.06 Location of openings in elevators is critical and affects hositway design and machine arrangement.

(a) Adjacent openings necessitate location of guide rails at the corners of the car platform (corner post construction). This arrangement limits the width of the doors that can be used and tends to restrict loading and unloading of hand trucks, etc.

(b) Opposite openings limit the location of the counterweight to the sides of the car. The car depth must be sufficient to provide necessary counterweight space between car guide rails and front or rear wall of the elevator shaft. Arrangement with an electric traction machine below is critical and a detailed layout is required to assure adequate space be provided for the machine and counterweight.

7.07 The design of the elevator affects not only the architectural contract documents, but those of the structural, electrical and mechanical consultants. The data required by these consultants must be developed and incorporated in the design of their systems.

(a) The structural engineer will require the following:

(1) Elevator reactions in an overhead machine installation are suspended loads doubled for impact plus the dead load of the elevator equipment over the elevator shaft. The structural engineer must then design the supports required for these loads.

(2) In machine below installations, the uplift on the elevator machine must be calculated in order to provide a suitable machine foundation. The overhead reactions will be a combination of the suspended load quadrupled and the dead load of the overhead sheaves and sheave beams.

(3) The elevator pit of elevators operating over occupied space must be reinforced to withstand buffer impact. The impact is determined on the basis of governor tripping speed used in a formula listed in the ANSI or local code.

(4) Guide rail reinforcement is required on large capacity freight elevators. The reinforcement may be in the form of structural steel channels, column backing or intermediate supports depending on class of service, elevator capacity and car size. As a guide, the need for rail reinforcement should be checked for Class A loading when elevator capacity exceeds 6,000 lbs. and car depth is greater than 14 feet. Freight elevators for Class C loading, regardless of capacity or car size, will invariably require some form of reinforcement. Reinforcing may also be required on passenger elevators where vertical distance between floor beams is excessive. Guide rails to be plumbed within 1/8" throughout entire length. Car and counterweight rails to be thoroughly cleaned and smooth. Cars, when tested, to be free from any noise due to rusty or rough guides.

(b) The electrical engineer will require the following:

(1) Electrical characteristics of the elevator equipment which is used as the basis for sizing electrical feeders and disconnect means.

(2) Electrical feeders and disconnect means for signal and control circuits.

(3) The location and number of junction boxes in the elevator shaft for car

lighting and ventilation, emergency alarms and communication.

(4) The elevator layout which will determine arrangement of machine room lighting and location of receptacles.

(5) Pit lights and receptacles.

(6) Secondary level or overhead sheave space lighting.

(c) The mechanical engineer will require the following:

(1) Heat releases for each piece of elevator equipment in order to provide suitable machine room ventilation.

(2) Direction for maintaining minimum and maximum machine room temperature. Minimum of 60°F. is recommended. Elevator manufacturers request that maximum temperature does not exceed 105°F., but experience with multi-elevator installations indicate designing for a maximum 95°F. temperature results in better and more trouble free elevator performance. It is recommended that the elevator manufacturer specify the operating environment for his equipment. When temperatures in the 90's are specified, try to use a ventilation system which utilizes building return air as supply to the elevator machine room so that air conditioning is not required.

8.0 FUTURE EXPANSION

8.01 Future vertical and horizontal expansion of the building must be considered in the selection of the type of elevator equipment provided in initial construction.

8.02 Design and planning for horizontal expansion must include:

(a) Location of the elevator core to suit initial and ultimate access to the elevators.

(1) Any scheme that involves adding elevators in the expanded area must consider that having more than one bank of elevators serving the same floors is extremely inefficient due to possibly providing more elevators than necessary to satisfy five minute handling capacity. Also, poor elevator interval may result from having, in total, more or the proper number of elevators in the building but not part of the same group.

(b) Shafts for future elevators may be used for other occupancy by slabbing over the shafts at each floor.

(c) If expansion is anticipated in the near future, installation of elevator machine beams, guide rails and brackets and elevator entrances may be desirable in the initial construction to avoid construction dirt, etc. involved with breaking out slabs for machine beams, chopping beam fireproofing for guide rail brackets and walls for elevator entrances.

8.03 Design and planning for vertical expansion must include:

(a) The number, size and speed of the elevators to satisfy the ultimate requirements of the building.

(1) Elevator shafts for future addition of elevators.

(2) Frequently, if expansion is not anticipated in the near future, it is more economical to provide elevators of slower speed initially and completely replacing the equipment when the building is expanded. In such cases the elevator shaft and particularly the elevator pit must be designed for the future equipment.

(3) Installation of machine beams, guide rails and elevator entrances in future elevator shafts should be considered as described for horizontal expansion.

(b) The use of basement type machines should be considered if the vertical expansion of the building will occur in several stages.

(1) As described earlier, relocation of sheave beams and not disturbing the elevator machine and control equipment is less costly than relocating overhead equipment.

(2) Basement machines are not recommended for speeds of over 350 F. P. M. Therefore, if the ultimate height of the building requires elevators rated for more than 350 F. P. M. consideration should be given to use of slower speed elevators initially and complete replacement in the future.

(c) Oil hydraulic elevators designed for future vertical travel should be installed with a jack assembly designed for the ultimate travel.

(1) A stop ring must be provided on the piston located to suit the initial travel of the elevator.

(d) Elevator equipment installed in the initial installation should be designed for the future requirements.

(1) Control equipment should contain switches and relays for the future floors but left unwired or space should be provided in the equipment for the future addition of these items.

(2) Car operating panel and position indicator faceplates should contain fixtures with numbers for future floors. An alternative to this is designing the fixture box faceplates for addition of future floors.

(3) Lobby control panels should contain at least space for addition of elevators to the bank as well as floor designations for any vertical expansion.

9.0 ELEVATOR OPERATION

9.01 The basic factor in determining the type of elevator operation is the number of elevators in the building. Floors served, occupancy and location of special areas are other factors which must be considered in selecting special operating features for the system.

9.02 Single elevator installations can be equipped for single automatic or selective collective operation.

(a) Single automatic operation can be specified for freight service when elevator travel is limited to two or three landings.

(1) A single automatic system has no "memory" circuits and a call can be registered only when the elevator is not in use. A signal is provided in each corridor push-button station to indicate when the elevator is ready to receive a call. Once the car responds to the corridor call the passenger has exclusive use of the elevator for car calls.

(b) Selective collective operation should be specified for freight and passenger service when an elevator serves three or more landings.

(1) Corridor calls may be registered at any time. The elevator responds to all car and corridor calls registered in the direction of car travel. Calls registered in the opposite direction of car travel will be answered when the elevator changes direction of travel.

(2) The elevator specification may include a home landing feature wherein the elevator will always return to a particular landing, usually the first floor, when the elevator completes all calls.

9.03 A two car installation should have not less than duplex collective operation. Two car group supervisory system should be considered in heavy traffic buildings.

(a) In duplex collective operation the elevators operate as a team. Calls registered behind one car are answered by the other. Only one car will respond to a registered corridor call. One car is designated as a home landing (usually the lower terminal) car. The other car is a free car. This assignment can change depending on position of cars as calls are completed. The home landing car will return to the home landing upon completion of calls and the free car will park at its last completed call or at a designated floor in the upper part of the building. The home landing car will respond to any corridor call at the lower terminal or basement. The free car will respond to any call above the lower terminal.

(b) When heavy traffic is anticipated in a building more sophisticated duplex operation is recommended. A group supervisory system, which includes a dispatching control, should be specified. Controlled dispatching will space the elevators in the building and minimize "bunching", that is, both elevators traveling in the same direction directly behind each other. The system should also include full load by-passing, which prevents a car loaded to a pre-determined percentage of capacity from stopping in response to corridor calls.

9.04 Elevator operation with a group supervisory control should be specified for all installations of three or more elevators.

(a) The exact modes of operation in group supervisory systems vary considerably among leading elevator manufacturers.

(1) The trend in the industry is away from the four, six and seven program systems in which elevators automatically vary dispatching from terminal landings in response to the dominating demand for service at various times of the day.

(2) Most elevator manufacturers have revised their systems to operate on an "on call" or "demand" basis. In most cases the basic system is supplemented by special features to handle particular traffic conditions or problems.

(b) All principal elevator manufacturers include a zoning mode in their operating systems. Basically zoning anticipates traffic demand and locates elevators to reduce the time the elevators respond to calls. Elevators are not required to make complete round trips through the shaft for dispatching but reverse at the lowest or highest call as the traffic demands. Experience has shown that a building properly elevatored for up-peak demand operating on the zoning mode will satisfy practically all types of traffic demand and reduce average waiting time at typical floors a minimum of 25% over systems operating on dispatching modes. Each elevator manufacturer's zoning operation varies. The variations depend on the particular manufacturer's approach to satisfy demand and/or to avoid patent infringements. There are two basic approaches to zoning. The following briefly describes these approaches.

(1) The building is divided into zones, usually equal to the number of elevators in the group. The main floor and basements always constitute one zone. At least one elevator is assigned to each zone. An elevator will be parked in each zone and answer corridor calls within that zone and reverse at the highest or lowest call in response to calls in that zone. One specific elevator is not assigned to a particular zone. Any elevator may be assigned to any zone depending on its availability. After completing all its calls any elevator will travel to a zone unoccupied by another elevator. Elevators will respond to all car calls even outside its assigned zone. An elevator passing through an occupied zone will respond to calls in that zone.

(2) The building is not divided into fixed zones of several floors each, and elevators assigned to such zones. Elevators park at their last completed calls regardless of location. Elevators will reverse at the highest or lowest completed calls as in assigned zone systems. This system divides the building into high and low zones, normally at the mid-floor of the floors served by a group of elevators. The floors are divided into a number of down zones with usually two adjacent floors constituting a down zone. When a demand is registered in the high zone, the system selects the highest available elevator in the high zone to respond to the demand. If no car is available in the high zone, the highest available elevator in the low zone is selected. Demand in the low zone is answered similarly. Since there are no fixed zones, particularly no main floor zone, absence of an elevator at the main floor when a demand is registered causes the first available car

to reverse and travel to the main floor. If no car has been at the main floor for a determined period, the nearest down traveling car is selected to by-pass all down corridor calls, except timed-out calls and travel to the main floor. Once an elevator stops for down calls it will always return to the main floor.

9.05 The traffic analysis made by the Architect or Consultant will determine the elevator operation required to satisfy the traffic demand. In addition to the basic group supervisory system, which may include four to seven traffic programs, such as up-peak, down-peak, balanced, zoning, heavy up or down, zone return and light traffic, special operating features are available for specific traffic conditions and should be included in the contract specifications. The following are some of the features that should be specified or considered.

(a) Independent Service — Permits removal of any elevator from group operation to operate independently of other elevators in the group. When selected, the elevator will operate only in response to car calls, all corridor calls are by-passed.

(b) Full load dispatch — Permits an elevator loaded to a predetermined percent (usually 50% to 80%) of capacity at the main floor to be dispatched immediately.

(c) Full load by-pass — Permits elevator loaded to a predetermined percent (usually 50% to 80%) of capacity to by-pass registered corridor calls.

(d) Nuisance Call Cancellation — Permits cancellation of car calls when number of passengers in the elevator is inconsistent with the number of registered car calls. (Some manufacturers accomplish this by weight in the car, others by failure to interrupt light rays as car stops for car calls.)

(e) Limited Door Reversal — Doors are equipped with an electronic door detector with an electrostatic field of about 4" in front of the leading edge of the doors. When the field is disturbed, doors will be prevented from closings and if closing will reopen doors only the distance of the zone of detection. (Available only from Otis Elevator Co.)

(f) Light Rays — Usually invisible twin rays. Interruption of either or both light rays causes doors to reopen and remain open as long as beams remain interrupted. Doors close immediately after beams are re-established. In group supervisory systems light rays should be specified which distinguish between car and corridor calls to minimize the timethat doors are required to remain open.

(g) Nudging — Available with either electronic door detector or light rays. When doors are held open beyond a predetermined period, safety edge, door detector or light rays become inoperative and doors close slowly or stop and will not recycle. During "nudging", a distinctive warning buzzer shall sound and the door closing power and speed shall be reduced.

(h) Preferential Service — The next available elevator will travel non-stop to a particular floor in response to a registered corridor call. (For use in buildings where special service is desired to an executive floor.)

(i) Convention Service — One or more elevators are automatically selected to travel to a particular floor immediately after one elevator leaves the floor with a predetermined load. (For use in buildings where cafeteria, auditorium or large meeting rooms are located above or below terminal landings.)

(j) Corridor Call By-Passing — During periods of peak up or down traffic, the system restricts elevator response to up or down corridor calls. Response to such calls can be limited to one or more elevators in the group. During up-peak, limited service is provided for down corridor calls and to up corridor calls during down-peak. (For use in buildings where working hours are staggered causing several peak periods at the same time as employees in the building are traveling inter-floor.)

(k) Basement Service — Limiting travel of elevators to basements only to periods other than up and down peak.

(l) Up Corridor — Down Car Call Service — When building contains more than one bank of elevators and one bank (high rise) is equipped with openings at all floors, the high rise elevators will respond only to up corridor calls and to down car calls for floors served by other elevators. (Provided to eliminate necessity of a passenger having to transfer from one bank of elevators to another for interfloor travel.)

(m) Clock Control — Although some special features and programs can be initiated automatically, the desired service can be initiated by programming through a 24 hour, 7 day clock. (Recommended when special conditions always occur at a fixed time of the day.)

(n) Corridor Push Button Failure — Elevators will make a regular pattern of stops in the event the corridor push-button station fails.

(o) Auxiliary Dispatching — Elevators will be dispatched through an auxiliary system should normal dispatching fail.

(p) Ceiling Exit Contact Bypass — A switch is provided in the locked portion of the car operating station arranged to bypass the ceiling exit. Elevator then travels at reduced speed. Purpose of this switch is to permit transporting long lengths of materials by passing them through the ceiling exit. Local codes must be checked to determine if this is permitted.

(q) Security Control — Elevators will not stop at the main floor when a switch in the starter's control panel is thrown and another floor becomes the dispatching terminal. Provided in the elevator systems in areas where building security must be maintained in the event of a riot or other disturbance.

(r) Top of Car Inspection Station — The standard installation as required by most codes provides for control of the station from the top of the car only. In order to insure safety during an inspection or maintenance operation, the station should be made operable by a key switch located in the locked portion of the car operating station.

(s) Alarm Bells — Alarm bells, required by most codes, must be located inside the building and audible outside the elevator shaft.

(1) In high-rise buildings where the bell may not be audible to the passengers in the elevator, an alarm bell should also be located under the car platform so persons in the elevator can hear a response to pressure on the emergency alarm button in the car.

(2) In multi-elevator installations the alarm should be located in a security or control area manned 24 hours a day. A visual signal should also be provided at this station to permit identifying the elevator in the bank in which the emergency alarm button has been pressed.

9.06 Service elevator operation should be of the collective type. Single car installation should be simplex collective and two car installations should be duplex collective. When a study of elevator requirements indicates the need for more than two service elevators, a basic form of group supervisory can be considered.

(a) "With" or "without" attendant operation should be considered in the elevator operation. If only "without" attendant service is selected independent service should be included in the specifications regardless of the number of service elevators required in the building.

(b) An extended "door open" button should be included in the specifications to permit doors to remain open for loading purposes. This operation provides for setting door open time for an adjustable period of from 0 to 30 seconds. Momentary pressure on the button would permit the doors to remain open for the pre-set period. Repeated pressure on the button will restore the extended open time. Registration of a car call will cancel the extended door timing.

(c) Car doors should be equipped with light rays to prevent door closing while a load is being moved through the opening.

9.07 Freight elevator operation should be collective type when more than three floors are served. Single automatic may be considered when the elevator serves three or less floors.

(a) The operation should include provision for "with" or "without" attendant service.

(b) Consideration should be given to providing key operated control of car and corridor call buttons as may be dictated by building security requirements.

10.0 ELEVATOR DOOR OPERATION

10.01 Power door operation is recommended for all types of elevators. Manual operation is available for vertical biparting freight elevator doors, but requires a great effort to open and close the doors. Manual operation for passenger type doors reduces efficiency of elevator service.

10.02 Door operation in passenger elevators is accomplished by a master electric door operator which is mounted on the elevator car. The operator drives the car doors which, in turn, actuates the hoistway door opening mechanism. Door operation is one of the most important factors in good passenger elevator design. Door time, the time required for doors to open, delay for passenger transfer and close, is one of the factors used in calculating elevator round trip time.

(a) Door closing speed is governed by Code and cannot exceed 1¼ F. P. S.

(b) Door opening speed is limited only by the equipment specified and available from manufacturers of elevator equipment. The following should be used as a guide in specifying door opening speeds.

Up to 100 F. P. M.	–	1 F. P. S.
200 to 350 F. P. M.	–	2 F. P. S.
500 F. P. M. and over	–	2½ to 3 F. P. S.

(c) The time doors remain open (door delay time) is adjustable. Normal door open time is 3 to 4 seconds. At many stops made by an elevator, this timing exceeds actual requirements. Auxiliary door controls, light rays as described in Section 9.05(f) of Elevator Operation, should be specified to provide the most efficient door operation.

(d) Premature door opening, that is, elevator doors starting to open as the elevator is leveling, is a desirable operation and contributes to elevator performance.

(e) Selective door operation should be provided for elevators equipped with opposite openings. Operation should be arranged so that only the door corresponding to the landing for which a call is registered shall open.

10.03 Freight elevator hoistway doors and car gates are usually independently operated. Door operators are provided for each hoistway door and a separate operator for the car gates. The coordination of the door and gate operation is accomplished electrically. (One manufacturer, Security Fire Door Co., uses a master operator for doors and gates but this equipment becomes competitive with individual operators only when the elevator serves more than six openings.)

(a) Door and gate opening is automatic as the elevator stops at a landing. Door closing is usually accomplished by constant pressure on a "door close" button located in the car operating panel and the corridor push button station.

(1) Automatic door closing is also available but not recommended due to the hazardous condition caused by vertical travel of the doors and gates. When specified doors should be arranged to remain open for a predetermined time before closing automatically. A warning sign should be prominently posted in the car enclosure and an audible signal given prior to the start of the closing cycle.

(b) Sequence operation of car gates and hoistway doors should be specified to reduce the hazardous effect of vertically traveling gates and doors. The car gate should precede the hoistway doors in the opening and closing cycles.

(1) Although not required by Code, a safety edge should be specified for the car gate. Should the safety edge touch a person or an object, the gate will return to the fully open position overriding constant pressure on the "door close" button.

(c) The door opening and closing speeds are not as critical as with passenger elevators. A speed of 1. F. P. S. opening and closing is recommended.

10.04 Door operation of Service Elevators is essentially the same as for passenger elevators. See Section 9 Elevator Operation for special requirements.

11.0 EMERGENCY OPERATION

11.01 Provision to operate elevators during emergency conditions must be included in the specifications. The extent of such provisions is sometimes dictated by local codes and others are optional or desirable.

11.02 Emergency elevator service in the event of fire is required by many local codes and should be provided in all new and, in general, all existing telephone buildings with one or more elevators. However, in some cities this service is not required in existing buildings of less than 70 feet in height from mean ground level. This service, also known as Fireman's Service, is described in Appendix E of the ANSI Code and many localities have adopted this Appendix as part of their elevator code or have slightly modified these requirements.

(a) In addition to the requirements of this Appendix, the following features should also be included in the specifications:

(1) After the elevator/elevators return to the main floor the doors, after opening to permit discharge of passengers, shall close and remain closed. A "door open" button or switch shall be included in the Emergency Service Fixture and become operative only when the elevator is operating on emergency service. Momentary pressure on the button shall cause the doors to open to permit an authorized person to enter the car and initiate emergency service by the elevator.

(2) An elevator operating on independent service and located at an upper floor shall automatically have its doors closed and return to the main floor.

(3) When a heat and/or smoke sensing device is used to initiate emergency service, the elevator/elevators shall be dispatched to the second stop above the main floor if the heat/smoke sensing device at the main floor initiates emergency service.

(4) Restoring elevators to normal operation shall be controlled only by means of the key switch at the main floor. Resetting the heat/smoke sensing system shall not automatically restore normal elevator operation.

11.03 Although not required by Code, operation of elevators on standby engine alternators should be considered in the design of all new buildings. Standby power is usually available for operating at least one elevator at a time. In some buildings where more than one bank of elevators is provided, operating one elevator in each bank should be considered. Transfer from normal to standby power may be manual or automatic. The primary function of operating the elevators on standby power is to return the elevators to the main floor to permit passengers in the cars to be evacuated. When this is complete then one or more elevators can be used to provide limited service.

(1) When only one elevator is provided in a building and adequate capacity is available in the standby system no special provision is required to operate the elevator.

(2) When operation of equipment must be selective due to limited standby engine power capacity, a two position switch should be provided at the main floor arranged to transfer power to the elevator when standby power for elevator operation is available.

(3) In multi-elevator banks, a selector switch containing "on" and "off" positions and buttons corresponding to the number of elevators in the bank should be provided at the main floor. The selector buttons would become operative only when the selector switch is in the "on" position.

(4) In buildings where two or more banks of elevators are provided and standby power is available to operate only one elevator at a time, a bank selector switch should be provided in addition to the individual elevator selector buttons. The master bank selector switch would contain an "off" position and a position for each bank of elevators. Transfer of standby power to the selected bank must be made at the master station to make the selected bank selector switch operative.

(5) Standby power selector switches should be located in close proximity to the elevators in order that each elevator can be observed and cleared of passengers before power is transferred to the next elevator. Individual elevator selector buttons shall be arranged so that if another button is accidentally pressed while one elevator is operating on standby power, it will not activate the second elevator.

11.04 Emergency lighting in the elevator car in the event of normal power failure is required by many local codes and should be provided in new and existing buildings. The source of the emergency lighting is not dictated by code and can be provided by one of the following methods.

(a) Connect car lighting to building 110 volt emergency lighting circuit provided transfer from normal to standby power is accomplished within ten seconds.

(b) Provide battery operated emergency light arranged to illuminate automatically when normal power fails.

(c) Provide separate incandescent light fixture connected to building 48 volt DC power supply.

(1) The ventilation blower in the elevator car is usually on the same circuit as the car lighting, therefore, it will operate if car lighting is connected to the emergency lighting circuit.

(2) If the emergency alarm bell circuit is not connected to a standby power supply which can make the bell operative within ten seconds after normal power failure, a battery operated alarm bell should be provided.

12.0 ELEVATOR SIGNALS AND FIXTURES

12.01 The selection of proper elevator signal devices contributes to efficient operation of an elevator system.

12.02 Hall position indicators which indicate the location of the elevator should be provided for all elevator installations. The principal purpose of the indicator is to show the position of the elevators and is particularly important in locating the elevator car in the event of any kind of trouble. Indicators should be electric type with floor designations corresponding to the floors served and direction arrows. Mechanical type is not recommended due to necessity for frequent adjustment. Digital read-out type indicators are available which eliminate large faceplates punched for each designation. This type should be considered in high rise buildings.

(a) Indicators for one and two car installations should be located over the elevator entrances at the main floor only.

(b) In larger installations, the indicators for all elevators in each bank should be incorporated in one fixture located at the main floor.

(c) The floor designation should be at least 1" high to permit easy reading.

12.03 Car position indicators similar to the hall position indicators should be provided in each elevator car.

(a) The indicator which advises the passengers in the car of the location of the elevator in the shaft should be located directly over the elevator car doors.

12.04 Hall lanterns should be provided in all multi-car installations. The signal given by the hall lantern in advance of the arrival of the elevator responding to the call will direct the waiting passenger to that elevator entrance and reduce loading and door open time. An audible bell should announce the arrival of cars.

(a) The hall lantern may be located directly adjacent to or over the elevator entrance.

(b) In selecting the fixture design, consideration must be given to the intensity of the visual signal and the lighting of the surrounding area.

12.05 Corridor push button stations of call register type should be provided for all elevators. Registration of a car will cause the button pressed to illuminate, eliminating repeated pressure on the button by other waiting passengers.

(a) A single riser of buttons will suffice in each multi-car bank of elevators. Experience indicates that a double riser of buttons for banks of elevators arranged facing each other on opposite sides does not improve elevator efficiency.

(b) In multi-bank installations where the high rise bank of elevators serve all floors of the building during certain periods of the day, the corridor stations at low rise elevator floors should contain a disappearing copy sign which illuminates appropriately when limited service is available at these floors.

(c) Stations in single car installations should include an "Out of Service" sign which becomes illuminated when the car is out of service for any reason.

12.06 Car operating stations should contain call register type floor buttons as described above.

(a) Single car passenger and freight installations require only one car operating station.

(b) In multi-car installations with center opening doors it is advisable to provide a car operating station on each side of the car opening.

(c) A single or main car operating station should consist of a car operating panel, service cabinet and telephone recess arranged with a common faceplate.

(1) The car operating panel should include all devices required for automatic operation, such as floor buttons, emergency stop and alarm buttons, door open buttons and fireman's service switch.

(2) The service cabinet should be equipped with a lockable door and contain key operated switches for car light, blower, top of car inspection station, service, motor generator, light rays and other devices required by the operation specified. Key operated switches, although behind a lockable door, are recommended to prevent tampering in the event the door lock is broken or left unlocked.

(3) The telephone recess should be equipped with a door with proper identification. The recess should be vertically located to be accessible by short persons.

(d) When two car stations are required, the main station shall include the car operating panel and service cabinet as described above. The other (auxiliary) station shall include a car operating panel and telephone recess as described above.

(e) Car operating stations in freight elevators may require that individual floor buttons be key operated for security reasons.

(1) Each floor button key switch may be keyed alike or individually keyed depending on security requirements. The key switches should be made subject to the building master-keying system.

(2) If with or without attendant service is specified, the station shall include switches necessary for such operation.

(f) The faceplate of the car operating panel may be engraved with instructions for use of the emergency alarm or call button. The characters should be 3/4" high. The following are suggested instructions.

IF ASSISTANCE IS REQUIRED
PRESS RED BUTTON MARKED "EMERGENCY ALARM"
AND CALL NUMBERS LISTED IN
EMERGENCY TELEPHONE COMPARTMENT*

* *It is preferable to have a direct ringing number to the Control Station, thereby eliminating any need to dial.*

(g) In multi-elevator installations the elevator number should be engraved in the faceplate or applied to the back of the telephone recess door.

(h) In addition to the telephone described above, consideration should be given to installing a speaker telephone similar to Type 3A which may be used should the standard telephone be busy or left off the hook.

12.07 Lobby control station should be specified for banks of three or more elevators. The station can consist of either or both of the following. If both are specified, they should be arranged in a common faceplate.

(a) Starter's control panel with lockable doors and containing telephone, speaker telephone and operating key for speaker telephone in the elevator cars, key operated switches for motor generator, service selection, standby power selection and other devices required by the specifications.

(b) Car motion and position indicator which should contain emergency service switch, floor designations, direction lights and elevator numbers. Digital read-out type floor designations with direction arrows are recommended over electric type because of reduction in size of the fixture and lower maintenance costs.

12.08 Floor directory signs should be provided in the elevator lobbies of all multi-bank elevator installations. The signs should clearly indicate the floors served by the elevator banks.

(a) If, for any reason, the floors served by a particular bank of elevators change at certain times of the day, the signs should provide for this change.

(b) These signs are usually provided in another section of the specification. They can be furnished by the elevator contractor if the fixture is incorporated in the design of elevator entrances or the fixture design matches other elevator signals.

13.0 ELEVATOR CAR ENCLOSURE

13.01 Passenger elevator car enclosures may be completely designed and specified or an allowance included in the specifications to cover the cost of an elevator car enclosure which will be designed and specified after award of the contract for elevator work.

(a) When the car enclosure is detailed in the contract documents, any savings realized from the elevator contractor's negotiations with independent car enclosure manufacturers revert to the contractor.

(b) When an allowance is included in the specifications, any savings realized from competitive bidding revert to the Owner. Similarly, if the allowance is exceeded, the Owner is responsible for the additional cost.

(c) Based on the above it is usually more advantageous to the Owner to use the allowance method, particularly if the project includes more than one elevator.

13.02 The Architect usually controls the design of the elevator car enclosure. The design will usually be in keeping with the materials and finishes used in elevator lobbies, etc.

(a) In reviewing the Architect's design of the car enclosures, the design engineer should consider the occupancy of the building when approving the type of material selected for the car walls, trim, ceiling and car fixtures. The use of the elevator should dictate the types of materials used. The material used for the interior finish of passenger cars should be specified to be non conbustible or with a maximum flame spread rating of 25 and a maximum smoke development of 50.

(1) In small equipment buildings when the elevator will be subjected to abuse resulting from movement of materials and supplies, walls should be faced

with a material which will resist such abuse. Rigidized stainless steel has been successfully used for such installations. Trim and car fixtures of satin finished stainless steel are also recommended for the resistance to abuse and easy maintenance. Similar materials should be used in larger buildings where service and/or freight elevators are provided.

(2) In larger buildings where aesthetics of the car enclosures are controlled by the Architect, the design engineer should review the material and finish selection for ease of maintenance with some consideration also being given to the abuse resistance of the wall materials. Laminated plastic wall covering in color or wood grain finishes is recommended for such buildings. Wood veneers are easily damaged and should be avoided if possible. Particular attention should be given to the hung ceiling design for ease of cleaning the materials selected.

(b) Car lighting should be arranged on two circuits.

13.03 Standard freight elevator car enclosures are of all steel constuction with 6 ft. high solid steel wainscot and usually expanded wire mesh above the wainscot. The car ceiling is also usually expanded wire mesh.

(a) Consideration should be given to the use of rigidized stainless steel for the car walls which would eliminate periodic painting required due to scratches in the painted finish of standard freight car enclosures.

(b) Car lighting should be recessed in the car top to avoid damage to the fixture.

(c) If a standard freight car enclosure is specified the specifications should include final painting by the elevator contractor.

14.0 ELEVATOR ENTRANCES

14.01 Passenger elevator entrance details are usually controlled by the Architect. It is preferred to have entrance details included in the contract documents. If details cannot be completed prior to issuance of contract documents an allowance can be included in the specifications to cover the cost of the elevator entrances.

(a) Detailing elevator entrances on the contract drawings is desired as work of other trades may be affected by the design selected.

(b) Baked enamel finish on steel doors is usually satisfactory in small buildings and typical floors of larger buildings. The Architect may select an ornamental metal such as anodized aluminum, bronze or stainless steel at the main and executive floors of larger buildings.

(c) Steel door frames should be specified with a baked on prime coat an final coat applied when the project is substantially complete. Experience has shown that door frames are invariably scratched and stained during construction and require repainting before occupancy.

14.02 Freight elevator hoistway doors are furnished under the elevator contract. Door frames, which are usually structural channels, should be furnished and installed under the Miscellaneous Iron section of the specifications. Sills which are usually formed of structural angles and plates should aslo be specified under Miscellaneous Iron.

(a) Doors should be specified with a prime coat finish. Final painting on the shaft side should be performed under the elevator contract. The corridor side of the doors and frames should be included in the Painting section of the specifications.

14.03 Elevator hoistway doors, freight and passenger, should be specified to be U. L. Listed Class B 1½ hour fire doors in approved frame assemblies.

15.0 ELEVATOR MODERNIZATION

15.01 A thorough survey should be made to determine the condition of all retained equipment and the extent of the repair and overhaul work required to restore equipment to a "like new" condition. The work required should be completely described in the specifications which should also include a complete description of the new items of equipment required for the modernization.

(a) The specifications should include exactly the work required and references such as "as required" and "as necessary" should be avoided.

15.02 The following major components can usually be retained, repaired and overhauled as dictated by the condition survey:

(a) Geared Elevator Machines:

(1) Worm and gear should be checked for wear.

(2) Bearings will usually have to be replaced.

(3) AC motors must be replaced or rewound for DC service. Commutators usually must be turned down, honed and undercut. Brushes should be replaced. Insulation should be checked and repainted.

(4) Brakes should be replaced by DC units and new linings and pins provided.

(5) Machine and motor alignment should be checked. If realignment is required, individual units should be pinned.

(b) Gearless Elevator Machines:

(1) Commutators should be turned down, honed and undercut.

(2) Insulation should be checked for shorts and repainted.

(3) Brushes should be replaced. Brush holders may also have to be replaced.

(4) Brakes should be completely rebuilt and new linings and pins provided.

(5) Bearings checked and replaced if worn.

(c) Motor Generator Sets:

(1) Same as Gearless Elevator Machine.

(d) Sheaves.

(1) Drive, deflector, secondary and compensation sheaves should be checked for groove wear and regrooved or replaced depending on the condition.

(2) Bearings should be checked for wear and replaced if worn.

(e) Governors.

(1) Governors should be completely overhauled including new bearings and pins if such work is less costly than complete replacement.

(f) Guide Rails:

(1) Guide rails, car and counterweight should be cleaned, realigned and all fastenings tightened.

(g) Ropes:

(1) Hoist Ropes — Unless excessive wear or diameter reduction is evident, hoist ropes are usually retained. Rope life is usually reduced when elevators are converted to automatic operation. Therefore, it is usually advisable to replace hoist ropes during the modernization if it appears that ropes will have to be replaced within a short time. This will also avoid loss of elevator service for rope replacement after the modernization has been completed.

(2) Compensation Ropes — Same as hoist ropes.

(3) Governor Ropes — Usually replaced.

(h) Buffers

(1) Spring buffers are retained if the contract speed does not exceed 200 F. P. M. If spring buffers hve been used for speeds in excess of 200 F. P. M. (sometimes found in old installations) new oil buffers should be provided.

(2) Oil buffers should be drained, flushed and refilled with new oil. Seals should be checked and replaced if worn.

(3) Buffer compression switches should be added to oil type car and counterweight buffers if none were provided in the original installation.

(i) Car Sling and Platform:

(1) Car sling can be reused and no additional work required.

(2) Car platform can be reused except when platform type load switches are added.

(j) Counterweights:

(1) Counterweights are always retained unless a change of some kind is made in location of rails. Specifications must include requirement that additional weights be provided to compensate for possible increase in weight of car enclosure, door operator, etc.

(k) Hall Fixtures:

(1) Hall lanterns, hall position indicators, starter's panel and floor directory signs can be retained if design is in keeping with the elevator lobby.

(2) Corridor push-button stations, if they include call register or illuminating type buttons, can be retained if design is acceptable.

(3) If design considerations dictate, the above fixture boxes can be retained and only the faceplates replaced.

(l) Door Frames and Sills:

(1) Unless unusual conditions exist or major renovation of the lobby and/or corridors is contemplated door frames and sills are retained.

(m) Painting:

(1) All retained equipment should be cleaned and repainted same as new equipment.

15.03 The following major items should be replaced and/or new equipment specified. Specifications describing new and replaced items should be as specified for a new installation.

(a) Controllers and Selectors.

Should be suitable for the elevator operation specified.

(b) Motor Generator Sets.

If existing control is AC Rheostatic.

(c) Door Operators.

Unless existing are of modern design and in excellent condition with no history of failures.

(d) Hoistway Doors.

(1) Unless doors are in good condition and bear required rating.

(2) Doors must be inforced for door operating equipment. If reinforcing of existing doors cannot be done, or reinforcement is costly, doors should be replaced.

(3) Ornamental metal main floor doors are usually retained or door facing is reapplied to new rated doors.

(e) Door Tracks & Hangers.

Door tracks can usually be reused but hangers are usually worn or difficulty is experienced in installing them on new doors. If doors are replaced door tracks and hangers should also be replaced.

(f) Hositway Switches.

Unless existing switches are approved enclosed type and compatible with elevator contractor's new equipment.

(g) Door Interlocks.

Unless installation is relatively new and interlocks are compatible with elevator contractor's equipment.

(h) Safeties.

Most safeties can be retained but are of a type which must be rewound. Self-resetting type should replace existing to eliminate tedious and time consuming resetting procedure.

(i) Guide Shoes.

(1) Although sliding type guide shoes can be rebuilt and reused, new roller type should be used on elevator cars to improve riding quality of the elevators and to eliminate lubrication of rails.

(2) Counterweight guide shoes should be rebuilt and reused if clearance does not permit installation of roller type.

(j) Elevator Car Enclosure.

Unless design is unique and car is in good condition, car enclosures are invariably replaced.

(k) Car Fixtures.

Unless fixture design is required to maintain design integrity of retained car enclosures.

(l) Wiring & Traveling Cables.

Conduit only may be retained if of approved type and in good condition.

15.04 The following items which may not have been included in the original installation should be specified in the modernization specification. All items should be specified as for a new installation.

(a) Emergency lighting.

(b) Hoistway access switches.

(c) Pit switches. To permit safe access to the pit for servicing, a manual switch should be provided in each pit to interrupt the power supply and apply brake independently of regular operating device.

(d) 110 volt convenience outlet (in car operating station or car base) and car top.

(e) Telephone test jacks (car operating station).

(f) Normal lighting on two separate circuits.

(g) Fireman's Service

(h) Standby power operation (if available).

(i) Counterweight screens (special design for elevators with compensation).

(j) Top exit contact with key-operated by-pass switch.

(k) Rope and tape guards.

15.05 Existing, New or Modernized Elevators.

(a) Elevators installed in major buildings or modernized prior to about 1962 were usually equipped with Group Supervisory Systems in which the elevators were programmed to respond to various traffic demands. These systems recognize four to seven traffic patterns which occur through the day and automatically program the elevators to satisfy the demand of the prevailing traffic pattern. Subsequent to 1962 leading manufacturers have redesigned their systems completely or have made available operating modes which are more responsive to traffic demands and provide more efficient elevator operation. The new systems or supplementary modes have proven that elevator service can be improved, particularly in single occupancy buildings where interfloor traffic is heavier than normal. The principal factor in the improved service is reduction in average waiting time at typical floors.

(b) Updating the elevator operation should not be finalized until a complete traffic survey of a building is made to determine the extent of the updating required to satisfy the traffic demand. Some elevator companies will make such a survey free of charge and recommend the updating required. However, it is recommended that an elevator consultant be retained to assist in collection of data and analyze the requirements of the building.

16.0 ESCALATORS

16.01 The most advantageous application of escalators is in a building where a constant flow of passengers is anticipated or where an extremely heavy demand vertical transportation is generated by the building occupants.

(a) The constant flow application would apply in buildings where relatively active departments are located on the lower floors of the building. In such an application the escalators would provide transportation for the occupants of the floor during peak and normal traffic periods and for above normal transient traffic.

(b) In buildings of large floor areas, the vertical transportation study should include a study to determine the effect on the elevator system if escalators are used to serve the lower floors of the building.

(1) Population of lower floors should approach 300 persons per floor in order to consider or justify installation of escalators.

(2) A study may reveal that installation of escalators serving the lower floors of the building will result in reducing the number of elevators required.

Reduction in the number of elevators frequently results in reduction in the initial cost of vertical transportation equipment and an increase in usable area.

(c) The use of escalators should be considered when a cafeteria is located in the basement of a large building. Depending on elevators to provide transportation to the basement level will create a double lower terminal situation and seriously reduce elevator efficiency.

(d) Escalators (48" size) may be used in some areas as a required means of egress, thus eliminating a required stair. Local codes should be checked for this application and fire protection and/or enclosures required.

(e) Where escalators are the primary means of vertical transportation, elevator service must also be provided to serve handicapped persons.

16.02 Escalator Characteristics:

(a) Size:

(1) Escalators are available in 32 inch and 48 inch sizes. The size of the escalator is determined by the distance between balustrades measured 27 inches vertically above the nose line of the steps.

(b) Speed:

(1) Single speed units are rated at 90 or 120 F.P.M. Two speed units are rated at 90 and 120 F.P.M. with manually operated key switches provided for selecting the operating speed.

(2) Two speed operation best satisfies requirements when heavy peak demand is anticipated morning, noon and evenings and relatively light traffic occurs throughout the balance of the day.

(3) Speed is measured along the 30° incline of the escalator.

(c) Capacity

(1) Optimum capacity of escalators is based on an average of 1¼ persons per step on 32 inch units and two persons per step on 48 inch units.

(2) Optimum capacity is rarely achieved. Realistic capacity is 75% of the optimum.

(3) Escalator capacity is rated in passengers per hour. The following table indicates capacity per hour:

Width	Speed	Optimum Capacity	Nominal Capacity
32"	90 FPM	5,000/hr.	3,750/hr.
32"	120 FPM	6,700/hr.	5,000/hr.
48"	90 FPM	8,000/hr.	6,000/hr.
48"	120 FPM	10,700/hr.	8,000/hr.

(d) All escalators are reversible. Selection of the direction of travel is by manually operated key switches.

(e) Provide emergency stop buttons and starting buttons at top and bottom landing and in pit. Button in pit to be "lockout" type.

(f) Starting switches shall be of the Key-Operated type and shall be located within sight of the escalator steps.

16.03 Location and Arrangement:

(a) Escalators should be located as close to and within visible range of the main entrance to the building.

(b) Escalators can be installed in various criss-cross and parallel arrangements. The arrangement is determined by the circulation pattern established for the building.

(c) Space must be provided at the top and bottom of an escalator run to permit safe access to the escalator run. The access space should be at least 8 feet deep, measured from the escalator newel.

(d) Dimensional data for layout purposes vary slightly among manufacturers. Location of support points and loads should be based on the most severe conditions required by the approved manufacturers.

(e) In multi-storied installations local codes may require fire rated enclosures or may permit use of fire shutters, sprinklers, etc. for fire protection. Local codes should be carefully checked for such requirements.

16.04 Escalator Drive:

(a) Escalators are driven by AC motors and reduction gears. The motor sizes for 32 inch units are 10 hp and 15 hp for the 48 inch units. Motor sizes increase when the rise exceeds 23 ft. One manufacturer has developed a modular escalator in which the drive unit is designed for up to 20 ft. rise and a drive unit is added for each additional run of up to 20 ft. The motor size is 10 hp for each module.

(b) The escalator drive, controller and disconnect switch are located at the top of the escalator run or within the escalator truss.

(c) Ventilation must be provided to dissipate the heat generated by the drive motor and friction in the system. If the machine space is enclosed it is usually necessary to provide mechanical ventilation. Grillwork around the machine space is adequate if the machine space is in an open area. Heat releases should be obtained from elevator manufacturers or the consultant.

16.05 Materials and Finishes:

(a) Materials for balustrades of standard escalators may be stainless steel, aluminum, bronze or porcelain enamel. Glass balustrading, lighted panels and fiberglass are also available. The Architect usually selects the material and finish.

(b) The balustrade material of standard escalators will dictate the material and finish of the deck covers, skirts and treadplates. The exposed areas of other types of balustrades may be stainless steel, aluminum or bronze.

(c) Material and finish of step assemblies are limited to the manufacturer's standards except when risers are not of the cleated type. The risers may be faced with the material used for the balustrade. (Cleated risers are recommended for all applications for safety reasons) When cleated risers are specified the finish of the recess should be baked on epoxy paint of a color selected by the Architect.

(d) The exterior covering of escalator trusses is not normally furnished by the escalator manufacturers. The only exception to this is when the Architect selects an ornamental metal covering and the alloy and finish must match the balustrades.

17.0 WINDOW WASHING EQUIPMENT

17.01 Power operated platforms for window washing should be considered for buildings with fixed windows. The minimum building height for which such equipment is considered may be dictated by local union and/or safety regulations which may place a limit on the maximum height windows are permitted to be washed from a ladder. Another factor to be considered is the means local window cleaning contractors have for washing windows above ladder limitations.

(a) Frequently the efficiency gained by washing windows from a power operated platform will offset the cost differential between fixed and operable windows. The Architect should be requested to prepare a cost analysis of these factors in order that a proper evaluation of the cost factors can be made.

17.02 Powered platforms consist of a platform suspended by wire rope from a car mounted on the roof. The platform travels vertically and is developed in a modular length to suit the window spacing. The roof car travels horizontally around the perimeter of the building and is located to suit the areas covered by the platform.

(a) The ANSI Code requires positive engagement of the platform with guides set in the building face for type F & T powered platforms. An exception to this requirement is permitted for building heights of less than 130 feet provided the platform exerts a minimum pressure of 30 p. s. i. against the building. Contact pressure may be reduced to 10 p. s. i. if workmen on the platform wear life belts and safety lines fastened to the platform or building structure.

(1) Where building guides are not provided the platform is suspended at the roof with the suspension points closer to the building than the attachment points on the platform to press against the building to provide guidance and stability.

(2) The use of T sections or specially shaped mullions set into the side walls of the building with guide shoes or rollers positively engaging such guides offer a more positive guide system than angulated suspension.

(3) Platforms may be self powered with the power unit, usually an electric hoist, mounted on the platform. This type powered platform is usually suspended by a single wire rope at each end of the platform. The ropes and power supply lines are suspended from a car on the roof.

(4) Powered platforms which contain only controls for vertical travel and all power equipment located on the roof car are usually suspended by two ropes at each end of the platform.

(b) Roof cars may be arranged to follow a track system on concrete pads located on the roof. The track system affords a more positive path of travel than a pneumatic tired car which must be steered by a workman. The maximum speed powered roof cars may be moved in the horizontal direction is 50 f. p. m.

(1) Roof cars which contain the power unit for vertical motion of the platform must be equipped with a more sophisticated and safer secondary braking system.

(2) Power units for horizontal movement of the complete system can be incorporated into either the two or four wire rope suspension systems.

17.03 Power operated platform design, construction and safety features vary among manufacturers. Minimum standards have been established in the American National Standard Safety Requirements for Powered Platforms for Exterior Building Maintenance—ANSI A120. 1-1970, which has been adopted in whole or in part by many cities and states. Subpart F, Section 1910. 66 of OSHA Rules and Regulations refers to this code and includes some deviations from the ANSI Codes.

(a) Two types of power operated platforms are covered by these documents.

(1) Type F-powered platforms are suspended by at least four wire ropes, two wire ropes at each end of the platform. Either cable of each pair is capable of supporting the load. Failure of any one rope will not substantially alter the normal position of the platform.

(2) Type T powered platforms are suspended by at least two wire ropes, at each end of the platform. Failure of one wire rope at either end would upset the platform's normal position but would not permit the platform to fall to the ground. Employees working on such platforms are required to wear safety belts attached to the platform or the building structure.

(b) Safety requirements are similar for both types of powered platforms. The major variations follow:

(1) Hoist drum diameter of type F platforms must be 25 times the rope diameter, type T drum diameter must be only 10 times the rope diameter.

(2) Hoist drums of type F platforms must have spiral "U" grooves which the wire rope must follow and only one layer of rope is permitted in a groove. Grooved drums are not required with type T platforms and no restrictions are placed on the manner in which ropes must lay on the drum.

(3) The power units for vertical and horizontal travel for most type F platforms are located in the roof car. the power units for vertical travel of the platform on most type T platforms are located on the platform, power units for horizontal travel are located in the roof car.

(4) The requirements for secondary brakes are more stringent for type F platforms than for type T platforms. If the roof car of the type T platform is equipped with the vertical power unit the more stringent requirements for the secondary brake apply. In addition to the more stringent mechanical and electrical requirements for secondary brakes for type F platforms, the type F secondary brakes are applied when platform speed reaches 125% of the rated speed, the type T secondary brake is applied when the platform speed reaches 140% of the rated speed.

(5) The maximum rated speed at which the type F platform may travel vertically is 75 f. p. m., 35 f. p. m. is the maximum for type T platforms.

17.04 Platforms and roof cars may be constructed of steel or other suitable material. The ANSI Code defines the design criteria regarding construction, stresses, deflection, loads, wind forces, etc. and it is the manufacturers' responsibility to comply with these requirements. The Architect's specifications should be based on complying with this criteria as minimum requirements.

(a) The design of the platform should be suitable for the configuration of the building and modular spacing of windows. Some manufacturers, usually manufacturers of type T powered platforms, use their standard equipment and modify it to suit the conditions. The type F platform manufacturers usually design the equipment to suit building design details.

(b) The roof car design varies among manufacturers. Standard designs modified only to suit the modular spacing of the windows are most frequently supplied by manufacturers of type T equipment. Roof cars for type F equipment are usually of custom design. Roof cars must be provided whenever it is necessary to move the working platform horizontally to working or storage positions.

(c) Safety devices must be provided to prevent horizontal travel of the platform unless the platform is at its uppermost position of travel, not in contact with the building or guides and all protective and interlocking devices are in proper position. Operating devices for vertical travel of the platform must be designed to be inoperative unless the roof car is mechanically locked at an established operating point.

(d) Safety devices and circuits and requirements for emergency operation are defined in the Code.

17.05 The height of the building should dictate the sophistication of the powered platform provided.

(a) Angulated suspension for low rise buildings is usually adequate. Consideration should be given to lack of stability due to reliance only on contact with the building. Development of a wind condition while cleaning is in process could present problems in returning the platform to roof level. Positive engagement with a building mullion or guide would reduce sway due to the sail effect of the platform.

(b) Equipping the platform with the power unit makes retrieval of the platform and the operators difficult in the event of a loss of power. Locating the power unit on the roof car permits hand cranking when loss of power occurs.

(c) Safety afforded by type F equipment is greater than available with type T equipment. Safety devices, design and construction of various components and double rope suspension offered in type F equipment reduce the possibilities of serious accidents.

18.0 OUTLINE ELEVATOR SPECIFICATIONS

18.01 Architects' and Consultants' specifications describing vertical transportation work are usually based on elevator manufacturers' literature and specifications. Since variations exist among the specifications of various manufacturers, it is advisable to review such specifications for proprietary items which may be unique or restricted by patents to a particular manufacturer causing other manufacturers to take exception to the specification when bids are submitted.

18.02 The format of the specification should be developed to avoid omission or repetition of the work required. Wherever possible, related components should be grouped to permit simple checking for completeness of the specifications.

(a) The specification, particularly on large projects where various types of vertical transportation are required, should be made up in sections which define the requirements for each system.

(b) The specification should include a General Requirements section describing general items which are applicable to all sections of the specification.

(c) Each type of equipment, such as passenger elevators (geared and/or gearless), freight elevators, service elevators, escalators, etc. should be described in individual sections. This arrangement provides a "package" for each system which is simple to use for reference for any purpose. Since many items required in elevator work are identical regardless of the type of elevator, an alternative to the above, when more than one type of elevator is required, is the "package" the elevator specification but identify each paragraph heading with applicable elevator numbers.

18.03 The General Requirements section of the specification should include the following:

(a) *Description of Work:*
List all sections included in the specification.

(b) *Work Described in Other Divisions*
Although many divisions may not include this paragraph, it is recommended that it be included in the specification for vertical transportation work. The following items may be used for format. Only the items applicable to the project should be used.

Legal pit, hoistway, secondary level, sheave space and machine room.

Installation of power feeders to starter panel of machinery including main line switch except that main line switch for escalator shall be furnished by the escalator contractor.

Emergency power feeders to auxiliary contacts on elevator controller.

Wiring between emergency power throw-over switch and controller in machine room for standby power operation.

Conduit and wiring between lobby panel and remote push-button station standby power selection switches.

Conduit and wiring between heat and smoke detection systems and controller in machine room for fireman service.

Lights and switch in pit, sheave space, secondary level and machine room.

Receptacles and outlets as shown on drawings.

Electric and communication trail cable outlets.

Structural framing including supporting beams for machine, sheave and dead end hitch beams, sills, buffers and escalator trusses.

Basement machine foundation

Pit ladder

Pumps in pits, if required

Trap door

Trolley beam

Smoke hole grating

Machine room ladder and railing

Subway grating floor in sheave and machine spaces

Hoistway and machine room ventilation

Freight elevator entrance frames

Final painting of passenger elevator entrance frames

Final painting of freight elevator entrances

Escalator pit access door

Finish material in escalator machine space cover

Enclosure, wellway railing and covering for escalator truss

Temporary guards around all openings

(c) *Codes and Standards*
Applicable for all vertical transportation work. Work shall conform to the following:

Codes and rules of City, State and other Civil Authorities having jurisdiction.

Latest edition of American National Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks, including all revisions, hereinafter referred to as ANSI Code. Design, clearances, construction, workmanship and material, unless specifically excepted, shall be in accordance with requirements of ANSI Code except where codes having legal jurisdiction include more rigid requirements.

Rules of National Fire Protection Association.

All electrical equipment and materials shall appear on latest Electrical Construction Material List published by Underwriters' Laboratories, Inc.

Installation of electrical equipment shall comply with all applicable requirements of the Electrical Division of the specifications.

All materials and workmanship shall be of highest quality and in accordance with the best standard practices. Also, call for a 2-year guarantee covering workmanship and equipment.

(d) *Permits & Tests*
Applicable for all vertical transportation work.

File drawings for approval of local authorities. Obtain and pay all fees and charges for permits, certificates of inspection, etc., as required for proper execution of work, including electrical work performed under this division of specifications. Deliver certificates in duplicate to Architect before final billing.

Make all tests required by governing codes, as described in latest edition of American Standard Practice for Inspection of Elevators — Inspectors' Manual * and other tests the Architect may deem necessary. Furnish all labor, material and instruments necessary for required tests.

Tests shall be performed in the presence of the Architect and the Con-

**Published by the American Society of Mechanical Engineers, 345 East 47th St., New York, N. Y. 10017* tractor's field superintendent. Notification shall be given 48 hours in advance of the scheduled tests. Any tests not witnessed by the Architect will have to be repeated at the Contractor's risk and expense. In certain Telephone Companies, Owner's representatives are required to witness all tests.

(e) *Maintenance Service*

Applicable for all new and modernized elevator projects.

Furnish regular maintenance service for a period of twelve (12) months after date of acceptance. Cost of Maintenance Service (contract) to be included with elevator bids to make comparisons. All work shall be done during regular working hours of regular working days. Service shall include 24 hour emergency callback service during the entire period. Contractor shall be responsible for full maintenance service calls made after normal working hours for the purpose of correcting an elevator failure which shall not be limited to removal of passengers from the elevator cars and securing the elevator. The repair work necessary to restore the elevator to normal operation shall be performed on that service call and prior to the up-peak of the next normal work day unless the elevator shutdown is due to the failure of a major component for which replacement parts are not available.

Replacement parts, such as fuses, brushes, carbons, contacts, relays, relay coils, etc., shall be readily available at the job site to permit repairs to be made as described above.

Service shall include regular weekly examinations of installation, necessary adjustments, greasing, oiling, cleaning of equipment, supplies and parts necessary to keep equipment in good operable condition. Replacement of parts made necessary by misuse, accidents or negligence by parties other than Contractor, is not included.

All maintenance and repair work shall be performed by the Contractor's personnel trained in proper maintenance procedures.

When Owner maintains the work after acceptance, the Contractor shall furnish the following initial stock of spare parts: fuses, carbons, contacts, relays (complete with coil) and relay coils. Fuses shall be furnished at the ratio of one set for each two cars with a minimum of one complete set. All other items shall be furnished on a one to ten ratio, with one as a minimum.

On elevator modernization projects where elevators are maintained by a contractor, the specification should state that the existing service contract will be suspended upon award of the contract for the modernization work and that the successful bidder will be responsible for maintaining the elevators until such time as the work is completed and accepted. This requirement will eliminate any problems that may develop should the modernization work be awarded to a contractor other than the service contractor. In such cases the following should be included in the specification.

The contractor shall be responsible for maintaining the existing elevators commencing with the date the contract for elevator modernization is awarded and after temporary acceptance of each elevator by the Owner.

The equipment shall be maintained by the Contractor until the work on all elevators is completed and accepted by the Owner.

The Contractor shall be responsible for keeping passenger elevators in service as described in TIME & MANNER of these specifications. The Contractor will not be held responsible for replacement of existing major items of equipment should they fail prior to the Contractor's scheduled date for the installation of a similar piece of new equipment.

Any such repairs will be subject to negotiation between the Contractor, the Owner and Architect.

On elevator modernization projects where the elevators are maintained by the Owner, the following should be included in the specification.

The Owner will maintain the existing elevators which are in operation while conversion work is in progress. As each elevator is converted and temporarily accepted for the Owner's beneficial use, the Contractor shall be responsible for full maintenance of the equipment.

The Contractor will not be held responsible for replacement of existing major items of equipment should they fail prior to the Contractor's scheduled date for the installation of a similar piece of new equipment.

Any such repairs will be subject to negotiation between the Contractor, the Owner and the Architect.

(f) *Operating and Maintenance Instructions*
The following should be included in the specification on projects where the Owner contracts for maintenance service.

Furnish to the Owner, before final billing, two sets of the following data bound in hard cover binders:

Complete wiring diagrams and single line diagrams showing electrical connections, functions and sequence of operation of apparatus connected with work.

Complete parts list and lubrication instruction.

Complete set of maintenance instructions and procedures in sufficient detail to permit Owner's personnel to perform basic maintenance operations.

Mount one set of final diagrams in the machine room. Prints shall be mounted on tempered masonite boards protected by plastic. Boards shall be held in a rack from which they may be individually removed.

The following should be included in the specification on projects where the Owner's personnel will maintain the equipment.

Furnish to the Owner, before final billing, three sets of the following data:

Three complete sets of wiring diagrams and line diagrams on cloth showing the electrical connections and functions of all apparatus connected with the installation both in the machine room and hoistway.

Three complete sets of "Sequence of Operations and Adjustment Procedures".

All the information outlined above shall be corrected to the installed conditions as of the date of final acceptance.

Mount one set of final diagrams in the machine room. Prints shall be mounted on tempered masonite boards protected by plastic. Boards shall be held in a rack from which they may be individually removed.

In addition, three sets of straightline wiring diagrams on paper shall be furnished to the Owner prior to the start of any work.

Three copies of all reference material, service manuals or other material describing the proper construction, operation and maintenance procedures. This material shall be completely detailed and shall include all measurements, values, setting, adjustments, tests, etc. for each component of the system. This shall include set and reset voltages on all relays, connected values of all resistors, values of all coils and other information of a similar nature.

This service manual shall describe in detail the proper method for setting, testing, checking, adjusting and repairing each piece of equipment. Diagrams and illustrations shall be included whenever possible. This information, bound in a hardboard looseleaf binder shall be furnished to the Owner prior to the submission of any billing for work. The manuals shall be updated to include any revisions prior to the submission of final billing upon completion of the work.

Three copies of a lubrication chart describing the type of lubricant to be used and all points on the equipment requiring lubrication, also the recommended frequencies of lubrication. One additional lubrication chart shall be framed under glass and mounted in the machine room.

Before award of contract, the Contractor shall review with the Owner the service manual information he plans to submit.

(g) *Training*

The following should be included in the specification on projects where the Owner contracts for maintenance service.

Provide competent instructor or instructors to fully instruct Owner's personnel in the basic maintenance, operation and emergency procedures for all equipment. The instruction period shall be for a period of not less than eight hours. At the conclusion of the instruction period, submit to the Owner a certificate naming those instructed and extent of instruction.

The following should be included in the specification on projects where the Owner's personnel will maintain the equipment.

Provide a competent instructor or instructors to fully instruct personnel appointed by the Owner in the following:

The proper maintenance and operation of the equipment. The course shall include, but not be confined to:

supervisory dispatching

relay timing

door operation adjustments

compounding of generators

selector adjustments

sequence of operation and adjustment procedures

voltage regulation

use of equipment and instruments

proper emergency evacuation procedures

The instruction periods shall be at a time established by the Owner. The maintenance and operation course shall be (Architect or Consultant shall insert time period)

At the conclusion of the instruction periods, the Contractor shall submit to the Owner a certificate naming those instructed and extent of instructions. Before award of contract, the Contractor shall submit to and review with the Owner a detailed outline of the proposed training material.

(h) *Temporary Service*

Applicable for all vertical transportation work and elevator modernization projects.

The Owner shall be permitted temporary use of the equipment after safety tests are performed and/or temporary certification is issued if he so desires. Temporary use of the equipment by the Owner shall not constitute acceptance or commencement of the guarantee and maintenance period.

The following should be included in the specification for all new elevator projects.

Should the Owner elect to use the equipment prior to final acceptance, the Contractor shall provide interim maintenance of the equipment commencing with the date temporary service is initiated to the date of final acceptance. The maintenance service shall include cleaning, oil, grease and adjustments necessary to keep the equipment in good operating condition.

(i) *Date of Acceptance*

Applicable for all vertical transportation work and elevator modernization projects.

The date of final acceptance and start of guarantee and maintenance periods shall be the date of a formal letter from the Owner to the Contractor accepting the work as complete.

On new multi-car installations the installation should not be accepted and guarantee and maintenance periods should not commence until the work on all elevators in each bank is completed. Acceptance in this manner assure that all adjusting for group operation is satisfactorily completed before acceptance. Since the Contractor is responsible for maintaining the elevators as they are placed in temporary service, it usually results in expediting completion of the entire bank. However, this requirement imposes a burden on the Contractor for elevator work and frequently his work is completed but cannot be accepted due to incompleted work of other trades or the General Contractor. Consideration should be given to the purchase of an interim maintenance contract on each elevator on a per diem basis as it is placed in service. This arrangement is more equitable to the elevator contractor and is commonly used in other than Telephone Company projects.

On multi-car elevator modernization work it is usually advisable to require that the elevator contractor be responsible for maintaining the elevators as each elevator is completed. This will eliminate any conflict between the Contractor and Owner's maintenance personnel as to responsibility for correction or adjustment of any malfunctions in the system.

(j) *Contractor's Use of Elevators*

Applicable on new projects where the General Contractor is expected to use one or more elevators for construction purposes.

Should the General Contractor require the use of one or more elevators during construction, he shall provide, at his expense, temporary car enclosures, required door frames and doors for protection of elevator hoistway openings, power, lights, signals, elevator operators, elevator maintenance costs and any special labor or equipment required for temporary service which is not part of the permanent installation.

Door frames, if required, shall be coordinated with the design of the elevator entrances to permit installation of the permanent entrances without removing or demolishing the hoistway wall. Shop drawings of temporary door entrances shall be submitted to the Architect for review. If elevator service is extended as construction progresses, the Contractor shall, at his expense, hoist the elevator equipment and arrange for reinforcing the structure as required to support the elevator equipment.

All equipment shall be restored to a "like new" condition at the General Contractor's expense prior to final acceptance of the work by the Owner.

(k) *Special Requirements*

The following should be included in the specification for elevator modernization projects to insure proper accounting and distribution of modernization costs.

Upon award of the Contract the Contractor shall submit a breakdown indicating the total value of materials and labor related to new equipment and to repair and overhaul various items of existing equipment which will be retained. The breakdown of the various items must be equal to the contract price. The breakdown shall include the total value of the material and labor for each of the following:

elevator machine and motor

motor generator set

guide rails

compensation sheaves

counterweights

buffers

hoistway doors and frames

governors

control equipment

door operators

car platform and sling

car safeties

ropes

car enclosures

hoistway switches

elevator corridor signals including hall lanterns, push-button stations, etc.

elevator car fixture including indicator, operating panel, etc.

wiring

general work

(l) *Protection*
Applicable for elevator modernization projects.

Provide protection on the corridor side of hoistway openings where work is being performed. Protection shall consist of fire retardant dust-tight plywood enclosures completely covering the openings. Caution: Minimize the time in which this tempory plywood is used in lieu of rated elevator hoistway doors.

Enclosures shall be kept neat and clean throughout conversion period.

When more than one elevator is installed in a common shaft the following should be included in the specification:

Provide continuous heavy gauge wire screening between elevator shafts when work is being performed in the shaft adjacent to elevator operating in normal service. Screening shall be installed to cover the complete area between walls and separator or structural beams except as required to clear operating equipment. Screening shall be secured to separator or structural beams at each floor level and be reasonably taut between walls and beams to prevent interference with the operating car.

(m) *Storage*
Applicable for elevator modernization projects.

The Owner will provide storage space for the new equipment required for each phase only, raw materials as required and adequate space for storage of tools.

Material shall not be stored in stairways, corridors or other areas which would restrict passage.

(n) *Discontinued Equipment*
Applicable for elevator modernization projects.

All replaced or discontinued equipment shall become the property of the Contractor and shall be removed from the premises.

(o) *Cutting and Patching*
Applicable for elevator modernization

projects where no General Contractor is involved.

Perform all cutting and patching required for installation of new equipment. Patch all holes and disturbed surfaces caused by removal of existing equipment. Patched areas shall be finished similar to adjacent areas.

Decorating or painting patched areas will be performed by the Owner.

This item may be enlarged to include specific items of work as found necessary on particular projects.

(p) *Time and Manner*

The specification should specifically state the sequence in which work is to be performed on elevator modernization projects and projects on which elevators are being extended vertically or a combination of these conditions.

An analysis of traffic demand will indicate the number of elevators which must be in operation during the modernization or construction period.

18.04 Detail project specifications should be developed in sections for each type of vertical transportation equipment required on the project. The Architect's consultants' or manufacturers' specifications for specific items should include the following and be arranged in the following format.

(a) *Description of Work*

This paragraph should identify the type of vertical transportation equipment covered by the specification section.

If expansion of the system is planned, the specification should include provisions for expansion. (See section 8.0)

(b) *Elevator Characteristics*

This paragraph should list principal characteristics of the equipment specified.

elevator type — (geared electric) (gearless electric) (hydraulic)

type of service — (passenger) (freight) (service)

contract capacity

platform size

contract speed

floors served

number of openings:

front
rear

travel

doors:

size

type

power supply:

single phase

three phase

The above characteristics are the most pertinent in the identification of the principal items of an elevator installation. Other items, such as machine location, elevator operation, door operation, etc. can be added to the tabulation but these items are described in detail in the body of the specification and listing them under Elevator Characteristics is not vital to the specification.

(c) *Elevator Performance*

Tolerance in contract speed with contract capacity of plus or minus 3% on new installations and plus or minus 5% on elevator modernization projects should be specified.

Brake-to-brake time will vary depending on contract speed and floor heights. (See paragraph 5.05 and 10.02 to develop this performance requirement.)

(d) *Elevator Operation*

Performance type description will vary depending on size of building, number of elevators, etc. and will determine the sophistication of the operation.

See section 9.0 for types of operation available and special features which may be required to satisfy the traffic demand and conditions in the building.

(e) *Emergency Operation (Fireman's Service)*
See paragraph 11.02 (a) for new installations.

See paragraph 15.04 (g) for modernizations.

(f) *Standby Power Supply*
See paragraph 11.03 for new installations.

See paragraph 15.04 (h) for modernizations.

(g) *Car and Hoistway Door Operation*
See paragraph 9.05 (e) and (f) — Passenger & Service Elevators

See section 10.0 " " "

See paragraph 9.06 (b) — Service Elevators

See paragraph 9.06 (b) and (c) — Freight Elevators

See paragraph 10.03 " " "

See paragraph 15.03 (c) for modernizations.

(h) *Elevator Machine*
See section 5.0 for new installations.

See paragraph 15.02 (a) and (b) for modernizations.

(i) *Machine Location*
Dependent on elevator design. Elevator manufacturer must provide machine beams for overhead machine installations.

See paragraph 8.02 (c) for new buildings designed for future expansion.

(j) *Sheaves and Sheave Beam Location*
Elevator manufacturer must provide sheaves, deflector, secondary or overhead, depending on elevator design and sheave beams for basement type installations.

See paragraph 15.02 (c) for modernizations.

(k) *Control System*
See section 6.0 for new installations.

See paragraph 15.02 (c) for modernizations.

(l) *Sound Reducing*
Geared machines and motor generator sets should be isolated from the structure.

Hydraulic power units should be isolated from the machine room floor.

(m) *Automatic Leveling*
The following leveling accuracy should be specified:

Plus or minus 1/4" - electric elevators with variable voltage control

Plus or minus 3/8" - hydraulic elevators

Plus or minus 1" - electric elevators with 2-speed AC rheostatic control

(n) *Controllers*
Controllers should be equipped with properly fitted doors.

(o) *Selectors*
Selectors should be equipped with doors or covers.

(p) *Automatic Terminal Stops*
Electric elevators must be equipped with normal and final limit switches. Hydraulic elevators require final limit switches only. All limit switch mounting brackets should be thru-bolted to the guide rails.

See paragraph 15.03 (f) for modernizations.

(q) *Door contacts and Interlocks*
An interlock must be provided on pit access doors when any part of the car (usually the toe guard) encroaches on the door opening when the car is resting on the compressed buffer. Manufacturer's standard specification is acceptable.

See paragraph 15.03 (g) for modernizations.

(r) *Emergency Exit Door Contacts*
Side exit contacts required by Code. Top exit contacts should be specified.

(s) *Guide Rails*
No special requirements. Manufacturer's standard specification is acceptable.

See paragraph 8.02 (c) for new buildings designed for future expansion.

See paragraph 15.02 (f) for modernizations.

(t) *Guide Shoes*
Roller types are recommended for all types of elevators except sliding type must be used for large capacity freight elevators.

See paragraph 15.03 (i) for modernizations.

(u) *Ropes*
Type of roping must be specified. 8 X 19 rope construction is recommended for all electric elevator ropes.

See paragraph 15.02 (g) for modernizations.

(v) *Compensation*
Rope type compensation is recommended wherever required. Chain type may be used on slower speed installations where space conditions are limited.

See paragraph 15.02 (g) for modernizations.

(w) *Guards*
Guards of approved design should be provided for the following:

Over and around all ropes at machine and secondary levels, governors and selector tapes or cables.
Over compensation and crosshead sheave.
Under deflector sheave.
Guards over roller guide shoes and door operator drives are required by some Telephone Companies.

See paragraph 15.04 (k) for modernizations.

(x) *Counterweights*
No special requirements. Manufacturer's standard specification is acceptable.

See paragraph 15.02 (j) for modernizations.

(y) *Counterweight Screen*
Required by Code on all installations without compensation. Some Telephone Companies require specially constructed screen or guard to prevent clear passage between compensation sheave and counterweight guide rails.

(z) *Buffers*
Spring type permitted up to 200 F. P. M. Oil type required above 200 F. P. M. Oil type should be equipped with buffer compression switches Buffers attached to counterweights (elevator modernization projects) are difficult and costly to equip with compression switches. Consideration should be given to waive this requirement.

See paragraph 15.02 (h) for modernizations.

(aa) *Car Platform and Frame*
Manufacturers standard specification may be used for this item. The following must also be included under this item:

Toe guard at entrance side of elevator.
Work light and grounded receptacle on top of car and beneath car platform.
Guard rail over top exit of car (installed around car perimeter).
Car threshold of selected material.
Finish flooring in car.

See paragraph 15.02 (i) for modernizations.

(bb) *Governors*
Manufacturer's standard specification is acceptable. Specification must also include overspeed switch.

See paragraph 15.02 (e) for modernizations.

(cc) *Safeties*
Manufacturer's standard specification is acceptable.

See paragraph 15.03 (h) for modernizations.

(dd) *Hoistway Access Switches*
Not required by Code but recommended to provide easy access to elevator shaft for maintenance and inspection.

See paragraph 15.04 (b) for modernizations.

(ee) *Pit Switch*
Should be located immediately adjacent

to pit access ladder or strike jamb of elevator pit door.

See paragraph 15.04 (c) for modernizations.

(ff) *Car Operating Station*
See paragraph 12.06 for new installations.

See paragraph 15.03 (k) for modernizations.

(gg) *Car Position Indicator*
Manufacturer's standard specification is acceptable. Specify type - electric or digital read-out type. Include direction arrows in electric type.

See paragraph 12.03 for new installations.

See paragraph 15.03 (k) for modernizations.

(hh) *Hall Position Indicator*
See paragraph 12.02 for new installations.

See paragraph 15.02 (k) for modernizations.

(ii) *Corridor Push-Button Stations*
See paragraph 12.05 for new installations.

See paragraph 15.02 (k) for modernizations.

(jj) *Hall Lanterns*
Manufacturer's standard design and specifications are usually acceptable unless the Architect prefers specially designed fixtures.

See paragraph 12.04 for new installations.

See paragraph 15.02 (k) for modernizations.

(kk) *Lobby Control Station*
See paragraph 12.07 for new installations.

See paragraph 15.02 (k) for modernizations.

(ll) *Floor Directory Signs*
See paragraph 12.08 for new installations.

See paragraph 15.02 (k) for modernizations.

m) *Car and Corridor Fixtures*
Material and finish of fixtures should be specified.

(nn) *Elevator Entrances*
See section 14.0 for new installations.

See paragraph 8.02 (c) for new buildings designed for future expansion.

See paragraphs 15.02 (l) and 15.03 (d) and (e) for modernizations.

(oo) *Car Enclosure*
Car lighting should be arranged on two circuits.

See section 13.0 for new installations.

See paragraph 15.03 (j) for modernizations.

(pp) *Emergency Lighting*
See paragraph 11.04 for new installations and modernizations.

(qq) *Painting*
All machine room and hoistway equipment should be cleaned and painted prior to acceptance. Surfaces of shop painted equipment is usually damaged or rusted during construction and should be repainted before acceptance.

All new equipment furnished for an elevator modernization project should be painted as described above.

(rr) *Wiring*
All wiring except traveling cables and short connections should be in metal wireways. Flexible conduit, not exceeding 18" in length, may be used for short connections where not subject to moisture or imbedded in concrete.

All conduit should be zinc coated with threaded type fittings. (Requirements for some Telephone Companies permit electric metal tubing with compression or lockscrew type fittings.)

All wire for light and power circuits should be National Electric Code Type THWN.

Traveling cables should have at least 20% spare wires. (Some Telephone Companies require that in addition to supporting traveling cables by the steel supporting strand, a second means of support, yoke or metal clamps be provided.) Separate traveling cable should be provided for emergency alarm circuit.

19.0 BIBLIOGRAPHY

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20.0 PASSENGER ELEVATOR PLANNING IN LARGE BUILDINGS

by James J. Murphy

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Basic Elements

How difficult was it to decide how many passenger elevators to install in that towering new metal and glass encased office building down the street? How the elevators should be arranged into banks of cars? The size and speed of the cars in each bank? In short, the overall planning of the installation. Not so difficult with the aid of common sense and a computation chart. Of course, the experience of the elevator manufacturers and consulting engineers can aid too. Resolving the basic elements of the problem, e.g., number, arrangement, size and speed does not require expert knowledge of elevator equipment; nor the prerequisite of being in the elevator business. Why not? Because the service capacity of a passenger elevator traveling to a certain number of floors and serving a specified number of tenants on each floor can be computed quite accurately. Furthermore, the maximum traffic that this occupancy will generate can also be forecast with accuracy. By setting up logical groupings of the elevators, their size and speed and the service results which each arrangement is able to provide, can be calculated and balanced against the expected traffic load. With this information at hand, the arrangement that is best for the building in question from the standpoints of service and cost becomes apparent.

Technical matters associated with the equipment itself, e.g., hoisting motor, operating controls, dispatching devices, cab design, etc., are most important but subsequent and subsidiary to decisions on the basic elements. While the manufacturers must bear the major responsibility for final decisions on the basic elements, owner, architect, engineer and building manager can have sound judgments as well and can help to find the best answers. The intent of this review is simply to provide an insight into the problem and the procedures for its solution in order that all concerned may talk a common language.

Nub of the Problem

Passenger elevators in an office building will operate throughout the 24 hours of the day, with most activity from 8:00 A.M. to 6:00 P.M. On business days, Monday through Friday, the greatest activity occurs during the five-minute period just prior to the reporting hour of the major proportion of the building's population, e.g., 8:00, 8:30 or 9:00 A.M. During this five-minute period, in a single occupancy building, as many as 20% of the building tenants, having a common reporting hour, may arrive in the elevator lobbies. In a building with diversified tenancy, this figure will range from 12-1/2 to 15%. These people probably have been racing the clock from the time they awakened. They may have dashed to catch a bus to the railroad station, spent up to an hour on the train, taken another bus to the building, been subject to the waiting and vicissitudes of these modes of travel, and finally entered the elevator lobby. The elevator ride is the home stretch, the end of the race. Will they win, will they get under the wire? Will they get to their office on time and avoid the boss's frown? These last 5 minute arrivals are in no mood to accept anything less than immediate elevator service.

This situation is the nub of the passenger elevator problem. If there are enough elevators in each bank to carry 15%, 20% or some other agreed proportion of the building occupancy to their floors in the critical 5-minute period, there are enough elevators to meet all other service demands that will occur throughout the rest of the day. After the morning IN peak period, there is a lull until the luncheon traffic begins with heavy down movement. This is followed by heavy down and up traffic which may also tax carrying capacity because of the many stops the cars will make in each direction. Then there is heavy up movement when the late lunch goers return. The lunch period will last about 2 or 2-½ hours. The afternoon lull carries on until the common leaving hour when the peak OUT traffic breaks quickly. The 5-minute period after the common departure hour will produce traffic as high as 25% to 30% of the occupancy due to leave. Despite the greater intensity of this peak, it does not tax elevator capacity more than the morning IN peak due to the fact the cars fill quickly at a few upper floor stops and then empty quickly at the lower terminal. During the morning IN peak the cars load quickly at the lower terminal but make many stops in distributing the passengers over the floors which the bank of cars serves. Since only one or a few passengers are discharged at each stop, a relatively long time is required for them to make their way out of the car. Therefore, if the number of elevators, their arrangement into banks and the size and speed of the cars in each bank are adequate to handle the maximum 5-minute IN traffic peak, they will satisfy all other tenant needs.

A 20-Story Building

By way of example, let us elevator a new 20-story building. For easy figuring, let us assume 10,000 sq. ft. of rentable area on each floor, 200,000 sq. ft. in all. At the time the building is designed, little, if any, information may be available as to the tenants who will occupy it. Office building occupancy will vary from floor to floor but approximates 1 person per 100 sq. ft. of rentable area. The figure can be refined for an actual case. We can reasonably presume that our hypothetical building will have 100 persons on each floor, and 1,900 on floors 2 to 20. Let's assume they all have common reporting hours and that ours is a single occupancy building. This means that as many as 20% of them or 380 in total, will arrive on the average in the elevator lobbies during the 5-minute period prior to the common reporting hour, i.e., 8:00, 8:30 or 9:00 A.M. Our task is to determine how many elevators are required to distribute these 380 people over 20 floors in 5 minutes with cars of the proper size and speed and arranged into banks serving different groups of floors for best service and minimum cost.

Arrangement into Banks

Serving all 20 floors of the building by a single bank of elevators is possible but objectionable for a number of reasons. The most obvious is the mob scene that would occur when 380 people arrive to board cars in a single elevator lobby during a five-minute period. Cars serving 20 floors would make many stops and incur long travel time to the displeasure of passengers whether they are racing the clock or not. The arrangement would be cumbersome and quite undesirable from a service standpoint. A 20-story building would seem to divide logically at the 10th floor, with one bank of cars serving to this level and a second bank above it. Though logical, this is a preliminary decision, a start. We shall see how it works out.

Size of the Elevator

The passenger capacity of an elevator cab in the kind of building we are considering will usually range in nominal size from 13 to 24 passengers. The actual loading is usually figured at 80% of nominal because at least equal service capacity is achieved without holding the car until a full complement has come aboard. A fully loaded car makes more stops and encounters delays at upper floors when passengers have to force their way out and others may have to step out and re-enter. The size of the car is a balance beteeen the rate of arrivals and floors served. If the car is too large, both the dispatching interval and the travel time will be too long. If too small, there is a tendency to crowding and more cars will be required. This is a cut and try matter. Car size is of greatest importance during peak periods. Let us base our initial computations on a 20 passenger car, with peak period loading of 80%, or 16 people.

Speed of the Elevator

Car speed for the kind of building under consideration could be from 500 to 800 ft. per minute. Speed is important in proportion to the rise. For a start, let's take 600 ft. per minute for the low rise bank and 800 ft. per minute for the high rise. Assume a first floor height of 16 ft. and floor to floor heights above the first of 12-½ ft. We have tentatively decided to have two banks of cars, 1 to 10 and 1, 10 to 20. The vertical travel to floor 10 would be 116 ft., a total of 232 ft. up and down. With a car speed at 600 ft. per minute, travel time is $\frac{232}{600} \times 60 = 23.2$ secs. To floor 20 the total travel would be 482 ft. and the travel time at 800 ft. per minute, 36.2 secs.

Loading and Unloading Time

We are taking 16 passengers aboard at the 1st floor. A commonly accepted rate for loading at the lower terminal is 1 second per passenger. There is no waiting for people to enter cars during the 5-minute IN peak. Loading time, therefore, is 16 secs. To unload these passengers at upper floors takes longer. The ones at the rear often want to get out first. An allowance of 1-1/3 secs. is a fair average for OUT passenger movement. With 16 passengers, unloading will require 21.3 secs.

The Number of Upper Floor Stops

How many stops will an elevator make when loaded with 16 passengers each wishing to get off at one of 8 upper floors in the low rise bank and at one of ten in the high rise bank? Although the cars in both banks stop at the 10th floor, tenants on this floor will naturally prefer the express. You may logically say the cars will stop at all floors in each bank since there are more passengers in the car than there are floors served. Not quite. The cars in the low rise bank will make an average of 7 stops per trip and those in the high rise 8-½ stops per trip. How do we know? By the theory of probability, mathematically expressed as follows:

$$S = F - \left[\left(\frac{P-P2}{P}\right)^{N} + \left(\frac{P-P3}{P}\right)^{N} + \cdots \left(\frac{P-P\text{ top}}{P}\right)^{N} \right]$$

Where S = Average number of stops above the first floor

F = Number of floors served above the first having tenants reporting at the common reporting hour.

P = P2 + P3 + - - - P top = Population of the upper floors having a common reporting hour.

N = Passenger capacity of the elevator.

Formidable? Yes, but all the hard work is removed by translation of this equation into the accompanying computation chart. Determining the number of stops becomes a matter of simple arithmetic. The expressions on the chart $\frac{P-Pr}{P}$ and $(\frac{P-Pr}{P})^N$, represent any of the expressions $\frac{P-P2}{P}$, $\frac{P-P3}{P}$, etc. and $(\frac{P-P2}{P})^N$, $(\frac{P-P3}{P})^N$, etc.

We have already stated that an average of 7 stops would be made in the low rise zone and 8-½ in the high rise. Here is the way it was done with the aid of the chart. The expression $\frac{P-Pr}{P}$ is computed for each floor. Since we are assuming 100 persons per floor, all will be alike. For the 9th floor, $\frac{P-P9}{P} = \frac{800-100}{800} = .875$. This value is found along the abscissa of the chart, followed vertically to intersection with the curve N = 16, and the value $(.875)^{16}$ is found on the ordinate to the right to be .120. Generally, population figures will differ from floor to floor and each floor will have different values for $\frac{P-Pr}{P}$ and $(\frac{P-Pr}{P})^N$. In that case the following computation form is helpful:

Floor	Reporting Population	$\frac{P-Pr}{P}$	$(\frac{P-Pr}{P})^{N*}$
9	100	.875	.120
8	100	.875	.120
7	100	.875	.120
6	100	.875	.120
5	100	.875	.120
4	100	.875	.120
3	100	.875	.120
2	100	.875	.120
Total	800	XXX	.960

Floors served (F) -	8.000
Total Column $(\frac{P-Pr}{P})^N$ -	-0.960
Total Stops -	7.040

N* = 16

The value of S is raised or lowered to the nearest quarter or third of a stop. In the above case S = 7.

Following the same procedure for the high rise bank:

Floors served (F) -	11.000
Total Column $(\frac{P-Pr}{P})^N$ -	- 2.420
Total Stops -	8.580

The number of stops is taken as 8-½.

Time for the Elevator to Make a Stop

As might be expected, more time is consumed by the elevator for stops than for traveling from lower terminal to upper floors and back again. Aside from passenger movement, which is a separate item in our computation, stop time embraces deceleration, leveling the car platform even with the floor, door opening and closing and finally acceleration to as nearly full speed as the proximity of the next floor stop will permit. Starting and stopping with today's elevators is so smooth we are scarcely aware of what is happening until the doors open level with the floor called for. The time required for the mechanical phases of starting and stopping depend on the power of the hoisting motor, the operating characteristics of its control equipment and upon the operating features of the car door. A center opening door is allowed to remain open for passengers to leave (or enter), before limiting devices take over to close it, is an additional element. Adding all factors together, 8 secs. is a reasonable estimate for our car to make a stop with the kind of equipment that would be installed in our theoretical but top grade office building.

Round Trip Time

We have now established all of the time factors necessary to compute the elapsed time for a car to load its passengers, discharge them on the floors in its service zone and then return to the first floor terminal for another trip. The computation following is based on our first estimate of the proper service zones for each bank of cars, their size and speed The procedure follows:

Bank -	Low Rise	High Rise
Floors Served -	1 to 10	1, 10 to 20
Travel Time -	23.2 secs.	36.2 secs.
Time for Loading -	16.0 "	16.0 "
Time for Unloading -	21.3 "	21.3 "
Time for upper floor stops (7 x 8 secs.)	56.0 " (8.5x8 secs.)	68.0 "
Time for Terminal Stop -	8.0 "	8.0 "
Total Round Trip Time -	124.5 secs.	149.5 secs.

Number of Elevators Required - First Arrangement

Having established the round trip time, we can now determine the service capability of the initial proposal.

	Low Rise 1 to 10	High Rise 1, 10 to 20
Number of trips per car in 5 min. $\left(\frac{300 \text{ secs.}}{\text{rd. trip time}}\right)$ -	2.4	2.0
Passenger carrying capacity per car in 5 min. (trips x no. of passengers) -	38.	32.
Maximum no. of passengers in 5 min. (P x 20%)	160.	220.
Cars required $\left(\frac{\text{max. passengers in 5 min.}}{\text{carrying capacity in 5 min.}}\right)$,		
computed -	4.2	6.9
actual -	4.	7.
Interval between cars leaving 1st floor		
$\left(\frac{\text{rd. trip time}}{\text{no. of cars}}\right)$ -	31.1 secs.	21.4 secs.
No. of cars leaving 1st floor in 5 min.		
$\left(\frac{300 \text{ secs.}}{\text{interval between cars}}\right)$ -	10.	14.
Total passenger carrying capacity in 5 min.		
(No. of cars leaving in 5 min. x No. of passengers per car) -	160	224

The above data permit an appraisal of the initial proposal. The four cars in the low rise bank will carry 160 passengers in 5 minutes. This is equal to the expected arrival traffic. The average dispatching interval between cars leaving the first floor, 31 secs., is acceptable. The seven cars in the high rise bank will carry 224 passengers in 5 minutes against 220 expected. The interval is excellent, 21.4 secs. Though seemingly adequate, this arrangement is not satisfactory. There is a disproportion of cars in each bank, which results in an imbalance in the quality of service, e.g., 31 secs. for the low rise zone and 21.4 secs. for the high rise zone.

Number of Elevators Required - Second Arrangement

The first logical adjustment for more suitable set up would be to increase the low rise service zone. This will increase the number of cars in this bank and improve the dispatching interval. Correspondingly, fewer floors will be served by the high rise bank, fewer cars will be needed and there will be a longer average dispatching interval. Let us raise the low rise zone to the 11th floor.

Under this arrangement, the population (P) of the low rise zone increases from 800 to 900, and the number of upper floors served from 8 to 9. We must recompute the number of upper floor stops. Since we have 100 persons per floor, the value of the expression $\frac{P-Pr}{P}$ for each floor is $\frac{900-100}{900}$ = .888. From the computation chart we find the value of $(.888)^{16}$ to be .170. For the 9 upper floors, the total of the probability expressions $(\frac{P-Pr}{P})^N$ is .170 x 9 = 1.530. Proceeding,

Floors Served (F)	9.000
Total $(\frac{P-Pr}{P})^N$ for all upper floors -	1.530
Total Stops -	7.470

The number of stops is taken as 7-½.

The same procedure for the high rise zone shows the probable number of stops to be 8-½. The travel distance for the low rise cars for a round trip increases from 232 ft. to 282 ft. and the time to 28.2 secs. The complete calculation follows:

Bank -	Low Rise	High Rise
Floors -	1 to 11	1, 11 to 20
Travel Time -	28.2 secs.	36.2 secs.
Time for Loading -	16.0 "	16.0 "
Time for Unloading -	21.3 "	21.3 "
Time for Stops (7.5 x 8 secs.) 8.5 x 8 secs.) -	60.0 "	68.0 "
Time for Terminal Stop -	8.0 "	8.0 "
	133.5 secs.	149.5 secs.
Number of Trips per Car in 5 min. -	2.2	2.0
Passenger Carrying Capacity per Car in 5 min. -	35.	32.
Maximum No. of Passengers in 5 min. -	180.	200.
Cars Required, computed -	5.1	6.25
Cars Required, actual -	5	6
Interval Between Cars -	26.7 secs.	25 secs.
No. of Cars Leaving 1st Floor in 5 min. -	11.	12.
Total Passenger Carrying Capacity in 5 min. -	176	192

The revised arrangement is an improvement. There is a better balance in the number of cars in each bank as well as in service quality. Total passenger capacity in 5 min. of both banks is slightly under maximum 5 min. IN traffic but the difference is not significant. These cars could be increased in size to 24 passenger capacity to offset this small imbalance but the penalty would be more stops, a longer round trip time, a consequent longer dispatching interval and unnecessary excess carrying capacity during most of the day. Even more significant would be a severe penalty in increased installation cost. Have we arrived at the best arrangement? Based on our various assumptions, I think we have.

Additional Floors

To test your working knowledge, would you like to compute the elevators required for a 10-story tower on our 20-floor building? Assume the area per floor to be reduced to 5,000 sq. ft., the same floor to floor heights, 100 sq. ft. per person to the 25th floor and 200 sq. ft. per person on floors 25 to 30. The 100 people on floor 20 would doubtless take advantage of the express facilities to this floor and would have to be included in our computations. Assuming car speed of 800 ft. per min., would you agree on 4 cars of nominal 13 passenger capacity (11 actual)? On a dispatching interval of 35 seconds? This is a bit long but it occurs only during the brief periods of intense traffic and is a small penalty for the quiet and the view that tower locations afford.

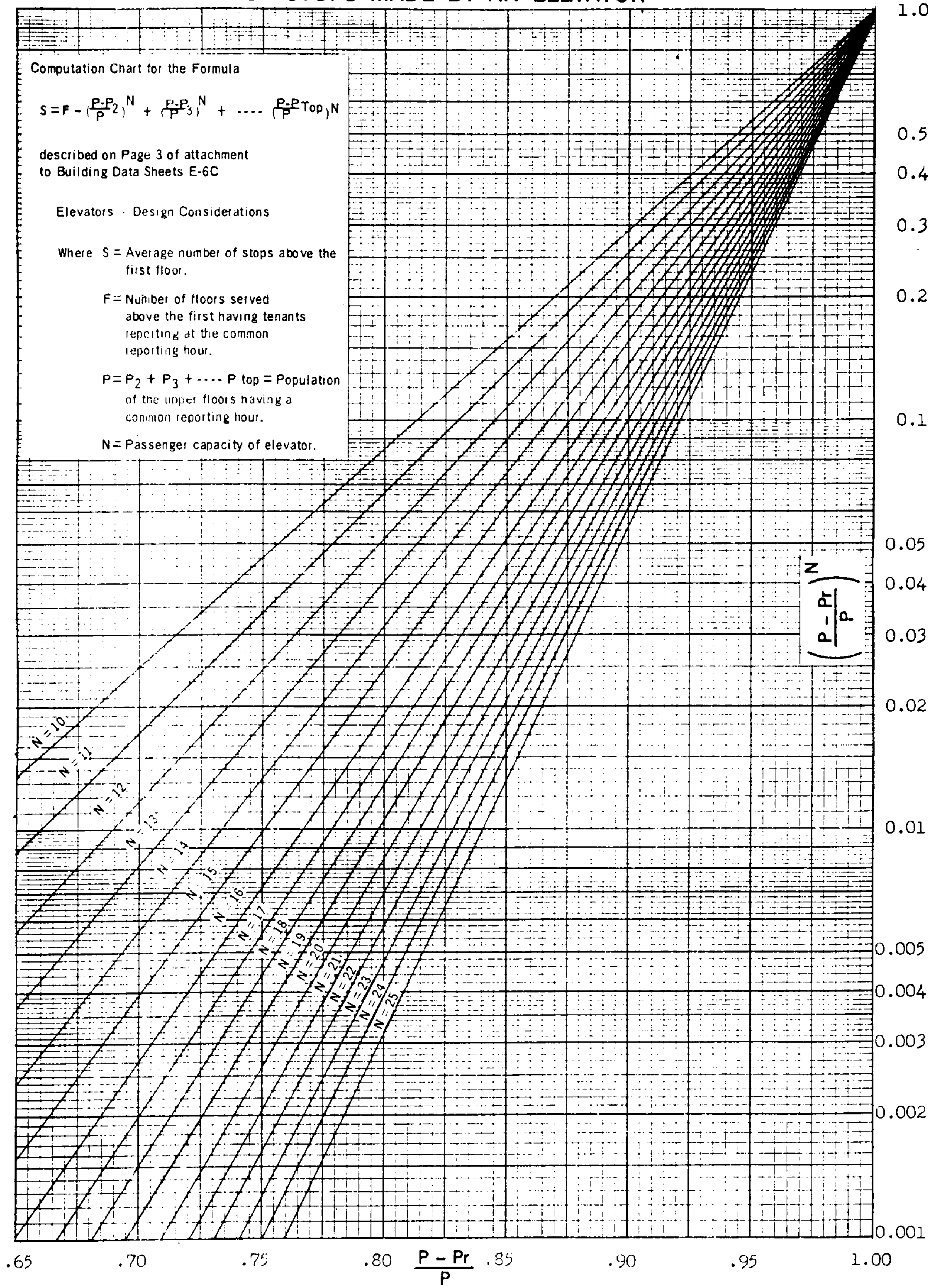
Service Elevator

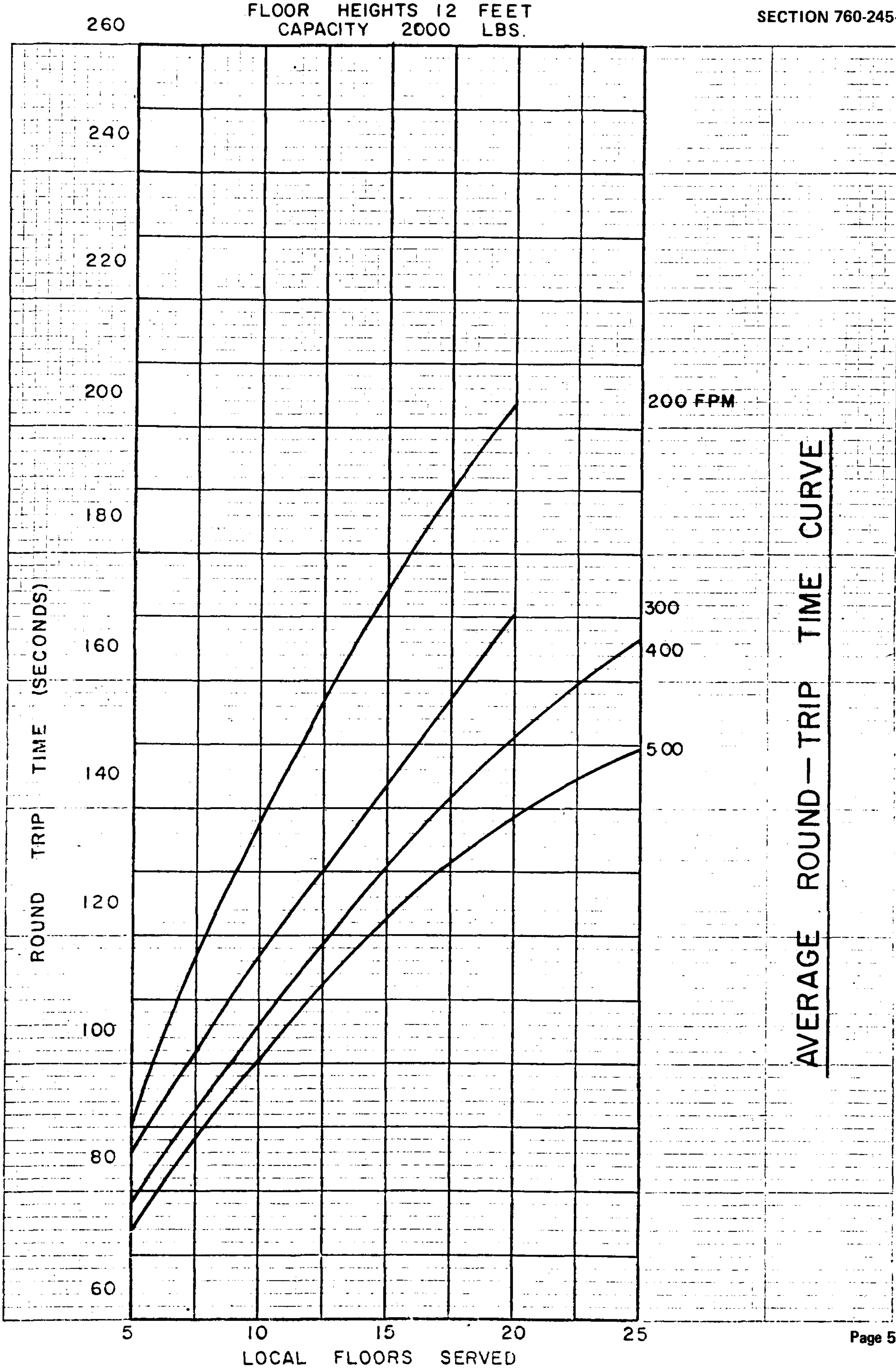
A spanking new office building would be incomplete without a service elevator to care for the needs of the operating personnel, package and freight deliveries, furniture moving, building alterations, etc. Our building should have a car of about 4,000 lb. capacity and a speed of 500 ft. per minute. It would be suitable also for emergency passenger service in the event of a shut down of one of the passenger cars. The service car would serve the basements and to the 20th floor. If the tower should be added, there are two choices. One, continue the service car to Floor 30. Two, increase the size of one of the passenger cars from 13 to 16 passengers in order to provide the extra platform space that service requirements demand. The latter arrangement is not as good, but might be adequate based on better knowledge of the actual occupancy expected in the tower.

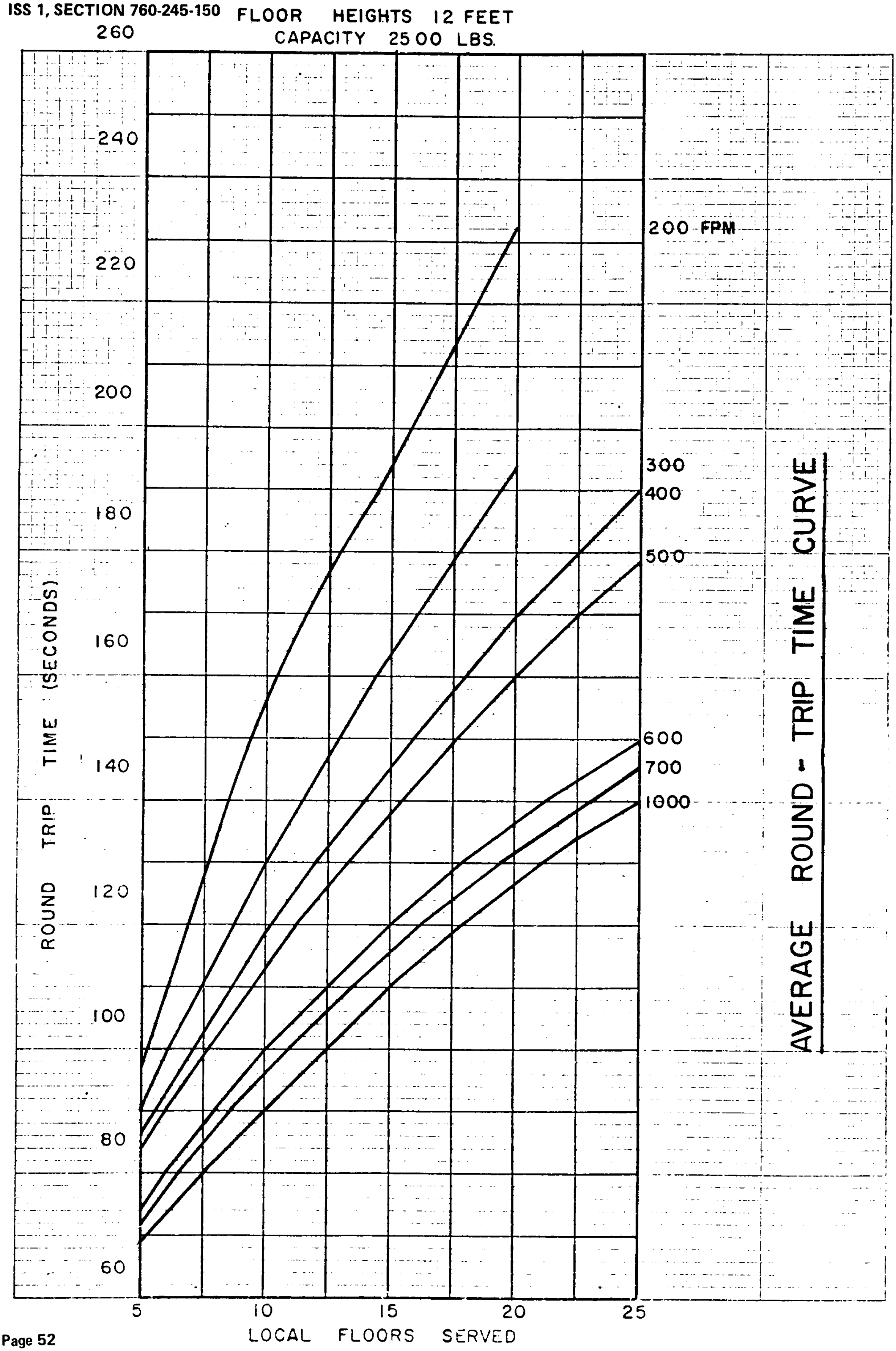
Basic Policy

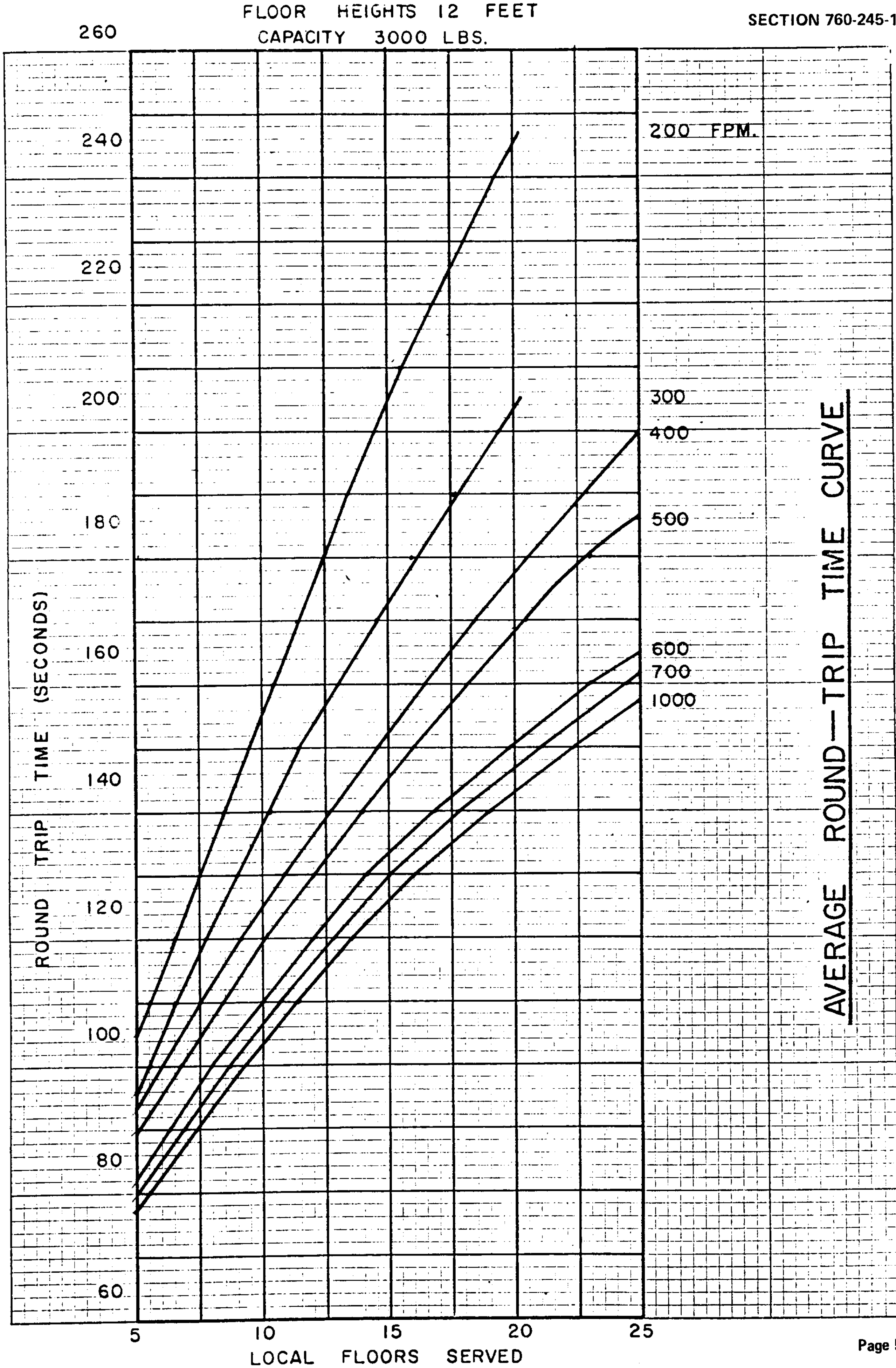
Elevator service gives life and spark to a building. How much life and spark depends upon its character. Unless elevator facilities are in step with character, the building will have an inherent inefficiency that will plague both landlord and tenants as long as it stands. The cost in lost time and dissatisfaction over the many years of its existence can be enormous. By all means, give this subject careful attention. The price for skimping is great.

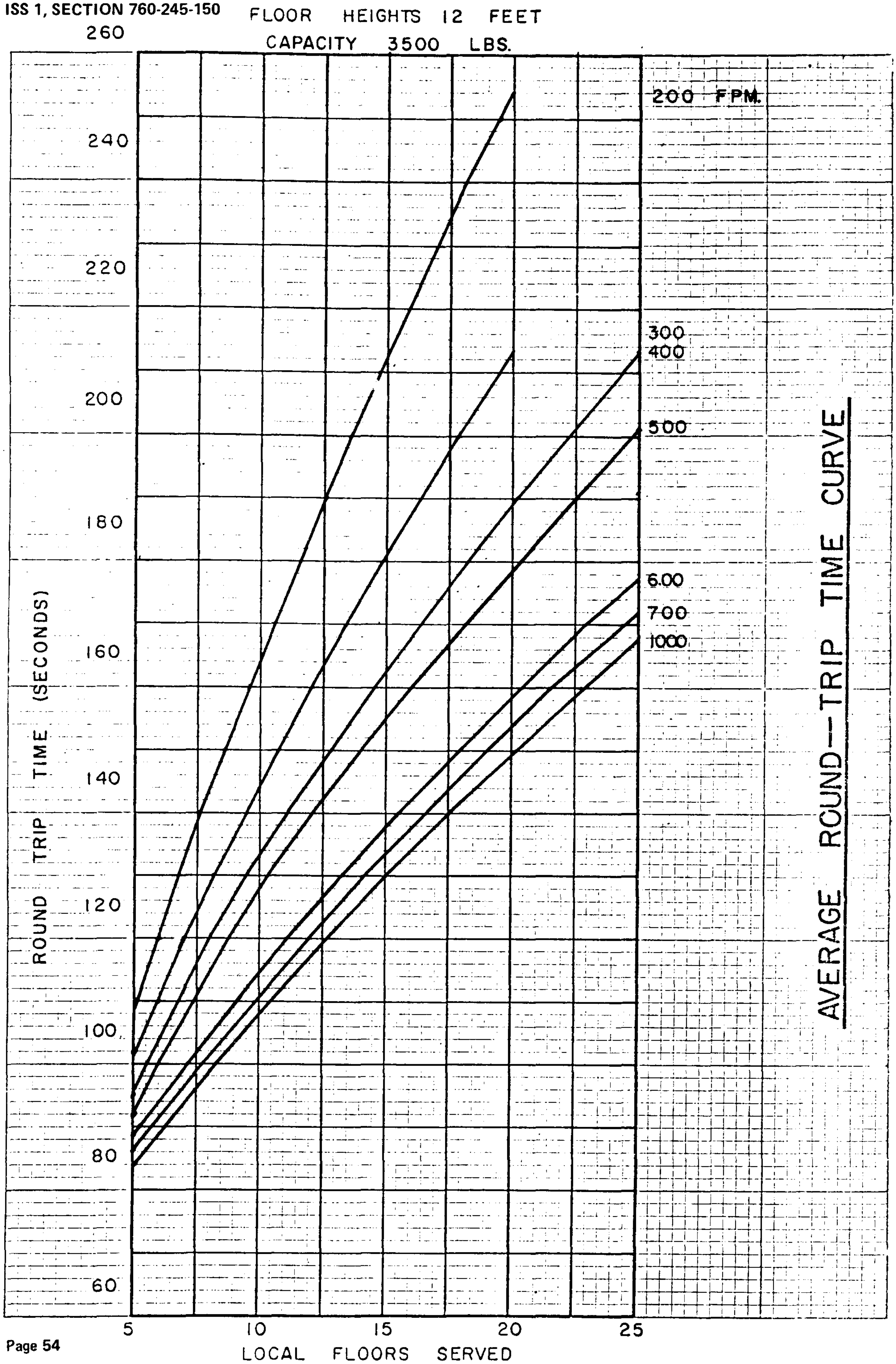
COMPUTATION CHART FOR NUMBER OF STOPS MADE BY AN ELEVATOR

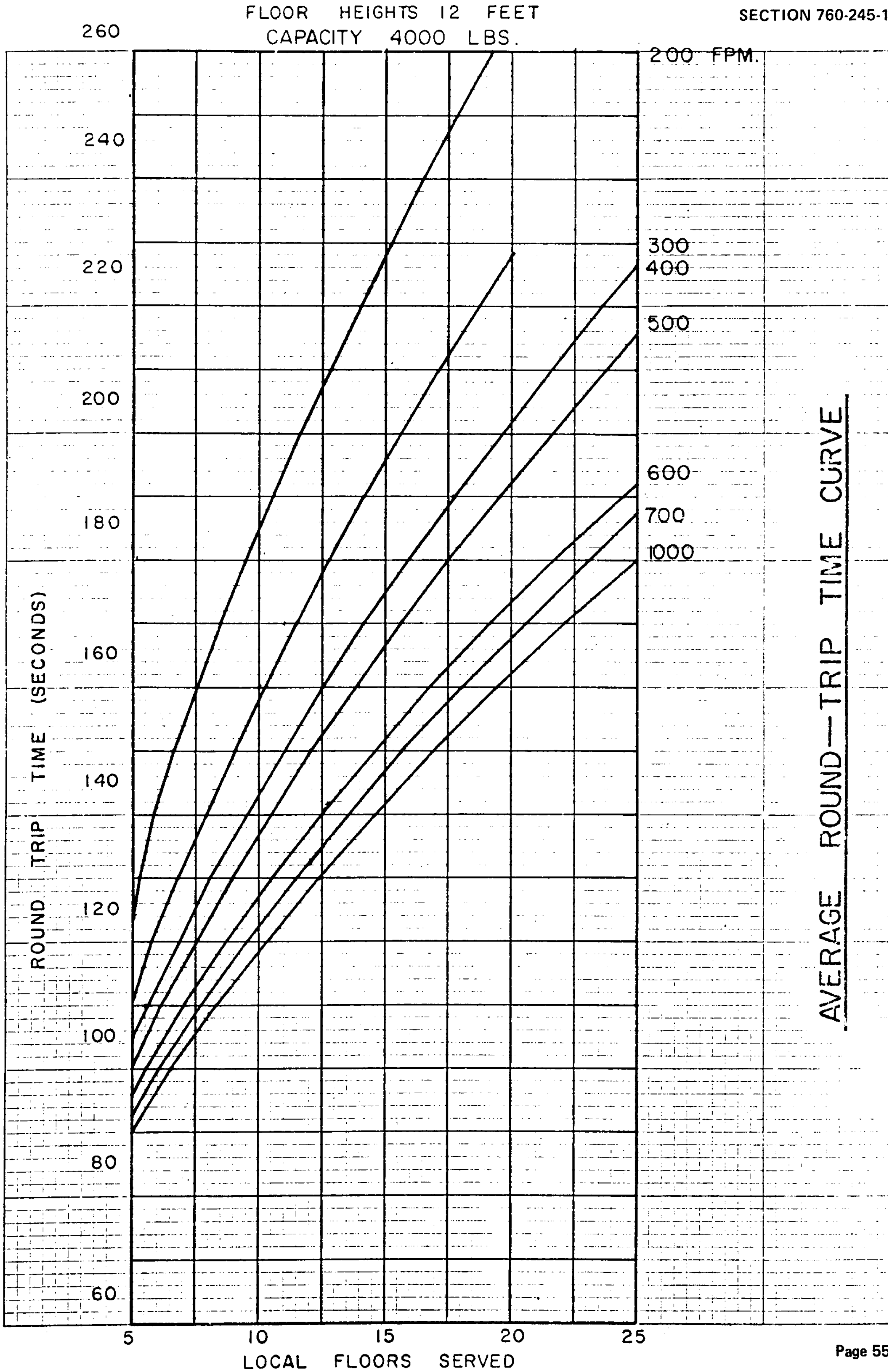


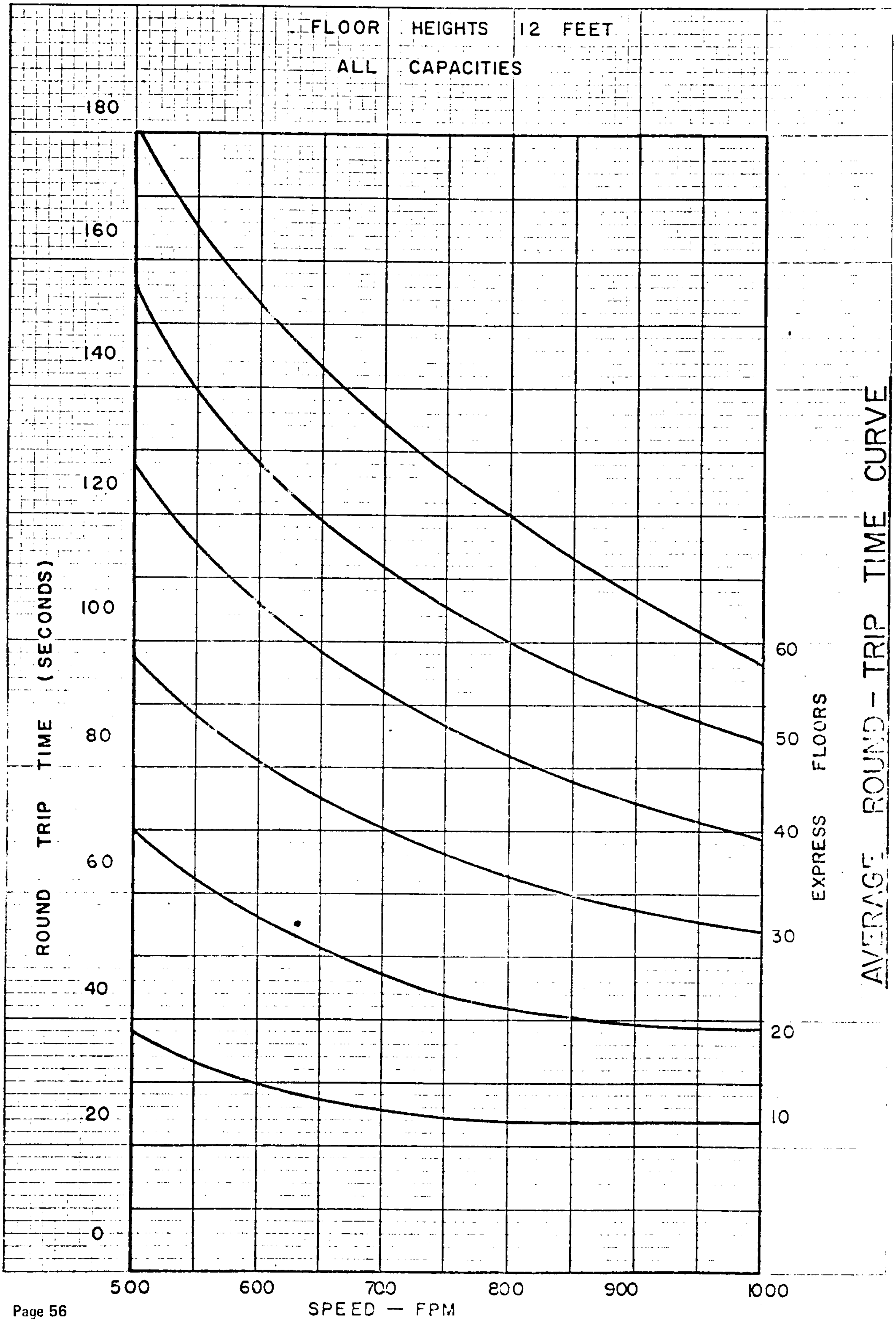

FLOOR HEIGHTS 12 FEET
CAPACITY 2000 LBS.
AVERAGE ROUND—TRIP TIME CURVE
ROUND TRIP TIME (SECONDS)
LOCAL FLOORS SERVED
200 FPM
300
400
500
260
240
220
200
180
160
140
120
100
80
60
5
10
15
20
25


FLOOR HEIGHTS 12 FEET
CAPACITY 2500 LBS.
ROUND TRIP TIME (SECONDS)
260
240
220
200
180
160
140
120
100
80
60
5
10
15
20
25
LOCAL FLOORS SERVED
200 FPM
300
400
500
600
700
1000
AVERAGE ROUND - TRIP TIME CURVE


FLOOR HEIGHTS 12 FEET
CAPACITY 3000 LBS.
AVERAGE ROUND—TRIP TIME CURVE
ROUND TRIP TIME (SECONDS)
LOCAL FLOORS SERVED
260
240
220
200
180
160
140
120
100
80
60
5
10
15
20
25
200 FPM.
300
400
500
600
700
1000


FLOOR HEIGHTS 12 FEET
CAPACITY 3500 LBS.
AVERAGE ROUND—TRIP TIME CURVE
200 FPM.
300
400
500
600
700
1000
ROUND TRIP TIME (SECONDS)
260
240
220
200
180
160
140
120
100
80
60
5
10
15
20
25
LOCAL FLOORS SERVED


FLOOR HEIGHTS 12 FEET
CAPACITY 4000 LBS.
200 FPM.
300
400
500
600
700
1000
AVERAGE ROUND—TRIP TIME CURVE
ROUND TRIP TIME (SECONDS)
260
240
220
200
180
160
140
120
100
80
60
5
10
15
20
25
LOCAL FLOORS SERVED


FLOOR HEIGHTS 12 FEET
ALL CAPACITIES
180
160
140
120
100
80
60
40
20
0
ROUND TRIP TIME (SECONDS)
60
50
40
30
20
10
EXPRESS FLOORS
AVERAGE ROUND - TRIP TIME CURVE
500
600
700
800
900
1000
SPEED — FPM