Naval Facilities Engineering Command
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ELEVATORS, ESCALATORS

DUMBWAITERS, ACCESS LIFTS

&

PNEUMATIC TUBE SYSTEMS

Design Guidance for Applications
& Selections of Systems

DESIGN MANUAL 3.09

MARCH 1986

ABSTRACT

Basic design guidance developed from extensive reevaluation of facilities is presented for use by experienced architects and engineers. Criteria are given for the design and selection of elevators, escalators, dumbwaiters, access lifts, and pneumatic tube systems for various buildings and facilities. Data required for the design include information on system basics, application, selection for buildings, controls, operation, and components. Contents cover the latest state-of-the-art as applied by major manufacturers in the field.

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FOREWORD

This design manual is one of a series developed from an evaluation of facilities in the shore establishment, from surveys of the availability of new technology materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command (NAVFACENGCOM), other Government agencies, and the private sector. This manual uses, to the maximum extent feasible, national professional and technical society, association, building code, and institute standards. Deviations from this design manual should not be made without prior approval of NAVFACENGCOM Headquarters (Code 04).

Design cannot remain static any more than the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy, from other federal agencies, and from the private sector and should be furnished to Commander, Western Division (Code 406), Naval Facilities Engineering Command, P.O. Box 727, San Bruno, CA 94066.

This publication is certified as an official publication of the Naval Facilities Engineering Command and has been reviewed and approved in accordance with SECNAVINST 5600.16, Review of Department of the Navy (DN) Publications; Procedures Governing.

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MECHANICAL ENGINEERING CRITERIA MANUALS

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Section 1: INTRODUCTION

1. SCOPE. This design manual contains data and criteria for elevators, escalators, dumbwaiters, access lifts, and pneumatic tube systems, including standard equipment sizes, basis for designs, and description of equipment and its operation. The ASME A17.1-84, Safety Code for Elevators and Escalators, and A17.2-85, Inspectors Manual for Elevators and Escalators, must be used as companion documents to this manual.

2. CANCELLATION. The material presented in this manual NAVFAC DM-3.09 cancels and supersedes Chapters 13 and 14,of DM-3, Mechanical Engineering, of September 1972, including changes 1, 2, 3, 4, and 5.

3. RELATED CRITERIA. Certain criteria related to the subject matter of this manual appear elsewhere in the DM-Series or Department of Defense Criteria. For these items, see list below:

Subject	Source
Access Lifts	
Swimming Pools	NAVFAC DM-37.01 (Interim)
Communication, Signal, and Alarm Systems	
Electrical Utilization System	NAVFAC DM-4.04
Elevators	
Facilities for Physically Handicapped	DOD 4270.1-M
Fire- Protection Criteria	DOD 4270.1-M
Fire Protection for Facilities	MIL-HDBK-1008
Inspection of Shore Facilities	NAVFAC MO-322 Vol.1
Medical Clinics and Dental Clinics - Design and Construction Criteria	NAVFAC DM-33.03
Naval Regional Medical Centers - Design and Construction Criteria	NAVFAC DM-33.02
Spacing of Elevator Banks	NAVFAC DM-1 Series
Noise and Vibration Control	NAVFAC DM-3.10
Emergency Power Systems	
Electrical Utilization Systems	NAVFAC DM-4.04
Pneumatic Tube Systems	
Architecture	NAVFAC DM-1 Series
Compressed Air and Vacuum Systems	NAVFAC DM-3.05
Noise and Vibration Control	NAVFAC DM-3 .10

4. CODES

a. Elevator Code. The code for elevators, escalators, and dumbwaiters named in this manual refers to ASME A17.1-84, Safety Code for Elevators and escalators, and A17.2-85, Inspectors Manual for Elevators and Escalators, published by the American Society of Mechanical Engineers (ASME) and adopted by the American National Standards Institute (ANSI). These codes establish minimum requirements and may be superseded by later supplements.

b. Electrical Code. The National Electrical Code. NFPA-70-84.

c. Pneumatic Tube Systems. There is no code addressed specifically to pneumatic tube systems. Equipment shall comply with NFPA-70 and the general construction safety orders of the locality.

5. SPECIFICATION. Based upon design criteria contained in this manual, NFGS-14200, Electric (Passenger) ((Freight) Elevators and NFGS-14214, Hydraulic (Passenger) (Freight) Elevators have been developed and are available for preparation of project designs.

Section 2: ELEVATORS

Part 1. CLASSIFICATION-CONTROL-OPERATIONS

1. CLASSIFICATION OF ELEVATORS. Elevators are classified in several categories.

a. Type of Motive Power. Electric or hydraulic.

b. Application. Passenger service and freight service are the only applications recognized by codes. combination freight and Passenger elevators (called "service" elevators) are classified as passenger elevators.

c. Control Systems.

(1) Generator field control.

(2) Solid state (static) control.

(3) Resistance alternating current using single-speed or two-speed alternating current motors.

d. Operation.

(1) Without Attendant (Automatic Operation)-Basic Control for New Elevators:

Nonselective collective automatic
Selective collective automatic (simplex and duplex)
Group automatic with dispatching

(2) Attendant:

Independent service
Attendant, automatic operation
Hospital emergency commandeering service
In-car emergency fire service (Phase 2 ASME/ANSI A17.1 rule 211.3a)

e. Typical Elevators. See Figure 1 and Figure 2 showing component parts and nomenclature of typical traction passenger and hydraulic freight elevators.

2. POWER SUPPLY. All power supply for new installations will be alternating current, generally 208 volts or 480 volts, three-phase 60 Hz.

3. DEFINITIONS. For terms used in this manual, refer to the Glossary and ASME/ANSI A17.1.

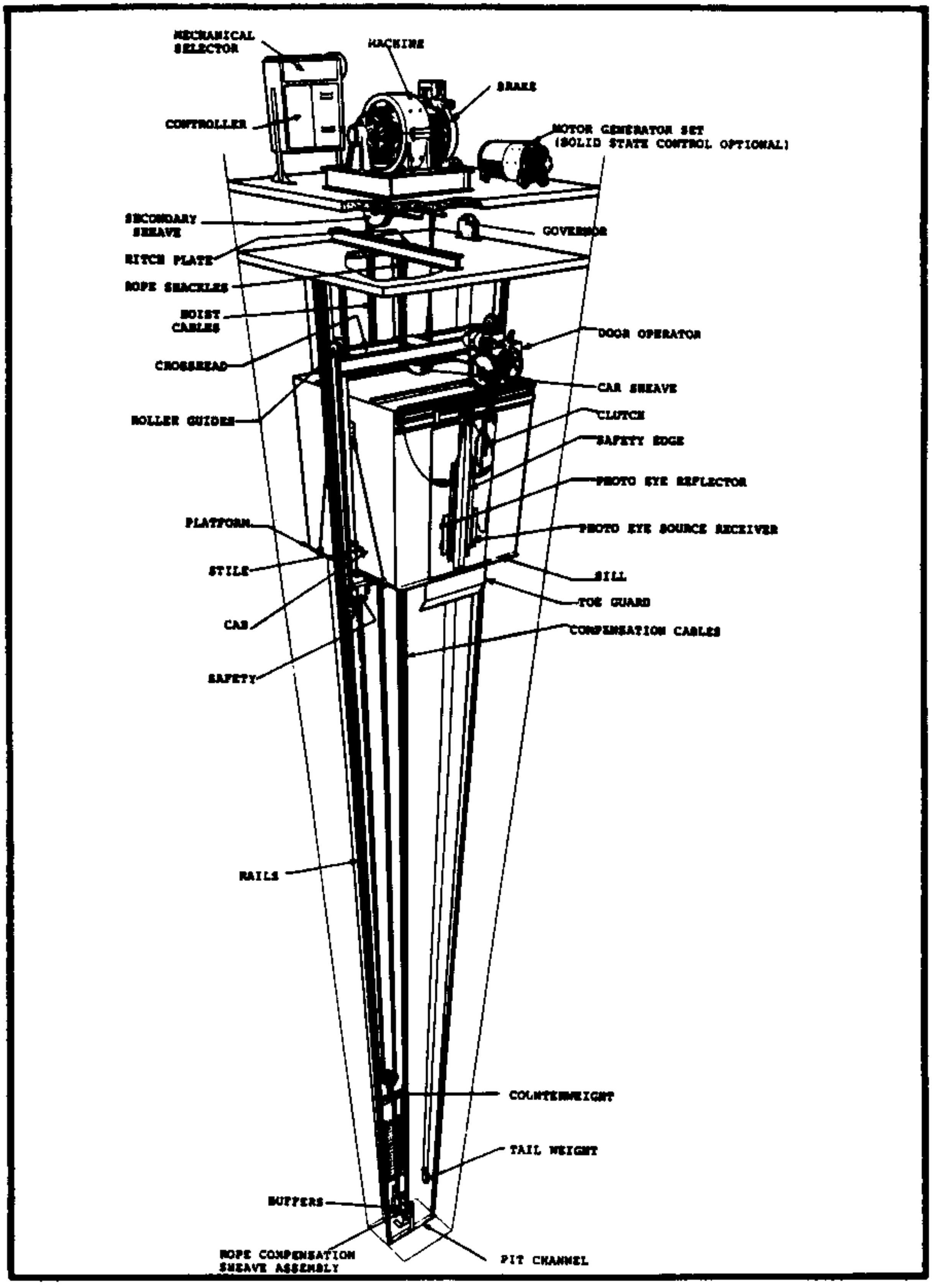


Figure 1
Traction Passenger Elevator

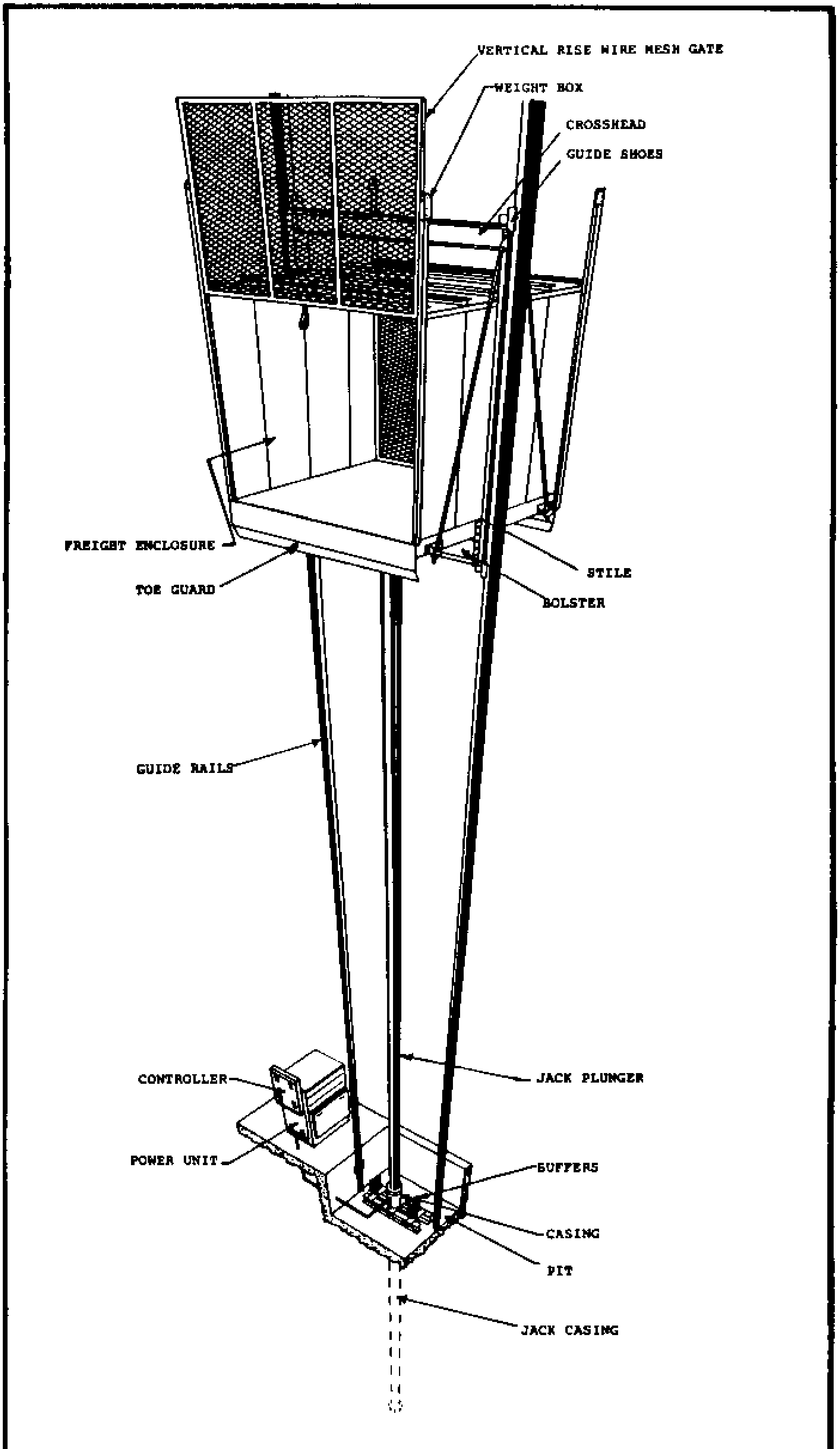


Figure 2
Hydraulic Freight Elevator

4. POWER CONTROL FOR ELEVATOR MOTION.

a. Hydraulic Pumping Plants. Use single-speed motors for hydraulic pumping plants and for a.c. resistance control of electric elevators to 50 feet per minute (fpm). Static controls and variable frequency controls for geared machines using single-speed alternating current motors are being offered by some manufacturers.

b. Speeds Up To 100 fpm. Can use two-speed alternating current for speeds to 100 fpm. Not recommended, as a rule, for electric elevators because hydraulic elevators are simpler and less expensive in this speed range.

c. Generator Field Control. Generator field control can be used for any capacity and speed for electric passenger or freight elevators and for dumbwaiters. A generator set for each elevator converts the alternating current to direct current which is applied to the elevator motor in varying steps of voltage.

d. Static Control. Static control is an electronic method of converting alternating current to direct current and should be specified as an option for geared and gearless passenger elevators because various designs of static or solid state motion control are now offered by some manufacturers.

5. LOGIC CONTROL.

a. Relay Logic. Mechanical controller relays for both electric and hydraulic elevators, and tape or wire-driven selectors are being replaced by solid state switching and electrical selectors.

b. Computer Logic. Microprocessors for logic control are becoming standard with all manufacturers for both electric and hydraulic elevators, but competitive specifications must allow either mechanical relays or static control for all elevators.

6. OPERATION.

a. Attendant Operations. Attendant operation by means of special auxiliary forms of attendant operation, i.e., independent service, hospital emergency commandeering service, or in-car fire service.

b. Nonselective Collective Automatic Operation (Called Single Button Collective). Suitable only for single car installations of three or four stops for light and intermittent service such at a barracks, where peak traffic at morning and evening is one directional. Car will stop in direction of travel to collect hall calls regardless of direction desired by hall passengers.

c. Selective Collective Automatic Operation.

(1) Selective collective is the preferable control for a single elevator when service is constant with several floor stops per trip in each direction during busy periods.

(2) For two cars, always use duplex selective collective so that the elevators operate as a team.

(a) Two elevators should have openings preferably side by side or in opposition on either side of the corridor.

(b) Two elevators with openings adjacent but at right angles can be used, but this arrangement is undesirable as confusion can result in the corridor.

(3) Do not use two single selective collective elevators side by side, because waiting passengers will press both buttons and cause false stops.

d. Group Automatic Operation.

(1) Group automatic is used for groups of three or more cars. A supervisory system must be specified to endure efficient response to car and hall calls.

(2) Modern systems embody computer-controlled call response and have superseded timed systems with multiple zoning.

(3) Special group operating features are often required, including:

(a) Security controls for entire system.
(b) Lockout of designated floors, car, or hall calls.
(c) Commandeering circuits, particularly for hospitals.
(d) Controls for operation in the event of a fire.
(e) Controls for operation in the event of an earthquake.
(f) Swing elevator for offpeak freight service.

e. Special Operating Controls.

(1) Fire Emergency Service. Provide fire service in accordance with ASME/ANSI A17.1 Code Section 211.3 for all elevators.

(a) A panel should be provided at the main floor containing the fire key switch, a locked compartment with fire keys, and operating instructions. The locked compartment shall be subject to the activities fire department key or the local fire department if the activity does not have a fire department.

(2) Emergency Power Operation. A standby power supply, providing emergency power to operate elevator in the event of failure of normal power, shall be provided for all medical buildings per DM-33.02, DM-33.03, and all other buildings as required by local codes or as directed by facilities planning.

(a) The electrical work shall include standby generator controls, automatic transfer switch, and circuits to elevator controller. All other circuitry is supplied in the elevator work.

(3) Earthquake Protection. Provides earthquake protection as required by ASME/ANSI A17.1.

Part 2. APPLICATION OF ELEVATORS

1. PASSENGER ELEVATORS.

a. Passenger Elevator Usage. Passenger elevators shall be specified for:

(1) Buildings with two floors or more must comply with Chapter 18 of DOD 4270.1-M except that of the following:

(a) Five stories or more in unaccompanied personnel housing.

(b) Four stories or more in unaccompanied officers' quarters.

b. Passenger Elevator Applications.

(1) Public passenger elevators are used for transportation of tenants, the public, and building personnel.

(2) Employee passenger elevators are used for transportation of building personnel in areas not accessible to the public.

(3) Hospital passenger elevators must be narrower and deeper than those for office buildings so that they can carry gurneys, beds, and other vehicles. Hospital elevators are used to transport the public, staff, visitors, patients, and vehicles including food carts of various types.

(a) In large hospitals public passenger traffic and vehicle and staff traffic should be carried on separate banks of elevators. Elevators dedicated to passenger traffic may be either all-purpose or of conventional, rather than hospital, design.

(b) Recent developments, particularly in cardiac surgery, require that beds with large balloons plus a team of nurses and doctors be moved from surgery to intensive care. Designer should check with hospital operations to determine what is to be carried and the elevator size.

(4) Private passenger elevators are for transportation of individuals located in areas not accessible to the public (e.g., classified areas).

(5) Elevators may be required for carrying prisoners in minimum and maximum security areas. For maximum security, an elevator with a separate prisoners' compartment with attendant or remote operation should be used. Remote-controlled elevators can deliver prisoners into secured areas.

(6) Elevators for morgue service in buildings where embalming and autopsy rooms are located should be adjacent to an ambulance loading dock and in an area not accessible to the public.

(7) Special purpose elevators are required for transporting maintenance personnel in antenna towers, smoke stacks, mines, launch sites, etc. Designer should consult the local Engineering Field Division for special design of these elevators.

(8) Separate elevators used for moving materials and service functions in large office buildings should be accessible to the building loading dock that enters onto a separate vestibule clear of the main traffic areas.

c. Passenger Elevator Capacity and Size. Passenger elevator capacities are determined by the net inside area of the car enclosure as indicated in ASME/ANSI A17.1, Figures 207.1 and 1300.1.

2. FREIGHT-ELEVATORS.

a. Freight Elevator Usage.

(1) Provide freight elevators in hospitals, shops, warehouses, and other facilities to carry the type, size, and magnitude of loads requiring transportation. Provide them in barracks with four stories or more.

(2) Vertical biparting power-operated doors are used.

(3) Freight elevators differ due to the type of loading, i.e., hand truck, power truck, automobiles, etc. It is essential that the type of loading be established; see rule 207.2b of ASME/ANSI A17.1.

(4) When a project requires the need of only one freight elevator, consideration should be given to utilization of this elevator for handicap use. This will require a combination passenger and freight elevator using passenger type doors.

b. Freight Elevator Application and Selection

(1) The platform size and shape of a freight elevator should be designed to handle the actual materials it is intended to handle.

(2) Door heights and cab heights depend upon maximum height of equipment to be handled.

(3) Any capacity can be satisfactorily served by hydraulic elevators for travels to 35-40 feet at considerable cost saving over electric elevators.

3. LOCATION AND ARRANGEMENT OF ELEVATORS.

a. Location. Elevators in office buildings should be convenient to main building entrances with heaviest traffic flows. Consider relationships of elevator locations to the extreme horizontal traffic flows of various floors. In buildings with very large floor areas, 25,000 square feet net and up, try to keep walking distance to elevators 125 to 150 feet maximum.

b. Elevator Groups. Preferably, each group should have a maximum of six cars; however, eight-car groups are often used in very large, heavily occupied, or single-purpose buildings. Means of venting hoistways and ventilation of machine rooms must be provided.

c. Arrangement. Arrange elevators in adjacent groups or with banks of cars facing each other. Alcove locations are satisfactory and simplify structural framing. Install no more than four cars in line in a single hoistway. If eight cars mist be in a group, install them in two banks of four each, opposite across a common lobby, but avoid four cars in line if possible, as door hold-open time of the end cars must be increased in response to hall calls, in order to allow time for waiting passengers to reach the entrance. Some local building codes limit the number of cars in a single hoistway to three.

d. Spacing. Use NAVFAC DM-1 series on architecture for criteria on spacing between elevator banks. Refer to National Elevator Industry, Inc., Vertical Transportation Standards. for hoistway sizes and layout information.

4. ELEVATOR SPEED.

a. Four Floors or Less. For two-, three-, and four-story buildings, such as small shops and barracks, with 12- to 15-foot floor heights, hydraulic elevators or electric elevators are applicable. For hospitals and medical clinics, see DM-33.02 and DM-33.03.

(1) Use hydraulic elevators for low budget, moderate service applications and for a maximum travel of 45 to 50 feet and maximum speed of 150 fpm.

(2) If electric elevators are used because service is severe or for improved operation, use a speed of 200 fpm.

b. Over Four Floors. Major buildings larger than four floors may require a complete analysis to determine the number, size, and speed of elevators needed to provide acceptable service for the project.

5. EQUIPMENT APPLICATION AND LIFE CYCLE COST. Each type of elevator has an optimum technical and economic field of application. Life cycle cost shown is for 20-year life.

a. Hydraulic Elevators. Speed range 50 to 150 fpm and 2 to 4 floors.

(1) The following are advantages of hydraulic elevators are:

(a) Lower original cost - $60,000 to $70,000.

(b) Lower maintenance cost - $36,000 to $60.000.

(c) Less expensive hoistway construction because load is carried in pit.

(d) Particularly adaptable for installation in existing buildings.

(e) Holeless designs available for some passenger capacities.

(f) Often applicable for replacements in existing hoistways or in localities where buried cylinders may be subject to corrosion or flooding due to high water tables.

(g) Pumping plant can be remotely located.

(h) Lower overhead height in hoistway, thirteen feet clear, and no penthouse required.

(2) The following are disadvantages of hydraulic elevators.

(a) Transmission of pumping plant noise and flow of hydraulic fluid to car enclosure and adjacent spaces.

(b) Heating under intensive service producing smell of hot oil.

(c) Possible corrosion and destruction of hydraulic cylinder with consequent high cost of $8,000 to $12,000 for replacement and a lengthy shutdown of elevator for two days to two weeks. Need for corrosion protection.

(d) Thirty to fifty percent less handling capacity than a comparable electric elevator because of slower inconsistent floor-to-floor time.

(e) Requires larger motor than equivalent electric elevator; for example, 40 horsepower vs. 12.5 horsepower.

(f) Possible excessive cost for digging cylinder well due to rock, boulders, water, and other adverse soil conditions - $500 to $10.000.

(g) No safety devices if bottom of cylinder fails.

(3) Life expectancy - 20 to 25 years.

b. Geared Traction. Speed range 50 to 350 fpm and 5 to 10 floors.

(1) Some manufacturers offer 400 and 450 fpm geared traction elevators. Four hundred fpm is acceptable but noise and-vibration have been encountered with both.

(2) The following are advantages of electric elevators over hydraulic.

(a) Superior operation and performance, better handling capacity.

(b) More consistent operation.

(c) Quieter operation.

(d) Smaller motors for a given capacity and speed.

(3) The following are disadvantages of electric elevators over hydraulic.

(a) Approximately 17 feet overhead height required plus penthouse.

(b) Higher original cost - $95,000 to $110,000

(c) Higher maintenance cost - $84,000 to $120,000.

(d) Hoistway must be designed to take overhead loads imposed by equipment in penthouse.

(e) Machinery must be located either overhead in a penthouse or adjacent to the hoistway at a lower floor.

(f) Seismic protection more extensive.

(4) Life expectancy: 30 to 35 years.

c. Gearless Traction. Speed range 500 to 1800 fpm and 10 floors or more.

(1) Gearless traction elevators, which represent the highest quality equipment available, may be used for passenger or freight service for any reasonable capacity and speed from 500 to 1800 fpm.

(2) For 10- to 15-story buildings, there is often a choice between geared and gearless elevators. This choice may not necessarily depend upon handling capacity and interval, but gearless elevators may be selected because of their superior performance and riding qualities and their longevity.

(3) The following are advantages of gearless elevators over geared.

(a) Ten to fifteen percent better handling capacity per car.

(b) Superior riding qualities.

(c) Quieter operation; no transmission of gear noise and vibration.

(4) The following are disadvantages of gearless elevators over geared.

(a) High original cost - $160,000 to $190,000.

(b) High maintenance cost - $168,000 to $192,000.

(5) Life expectancy: 40 to 50 years.

Part 3. SELECTION OF ELEVATORS FOR BUILDINGS

1. LOCAL CONDITIONS. The required number of cars, their capacity and platform size, speed, and operation is determined by the following factors which require a complete analysis which can be obtained from elevator manufacturer's representative.

a. Type and Use of Building.

b. Size and Height - Net Area.

c. Exterior Traffic Considerations.

d. Population of Building.

e. Anticipated Traffic Flow.

2. CRITERIA FOR SELECTING PASSENGER ELEVATORS.

a. General. The goal is to specify the minimum number of elevators with the most economical capacity and speed which will move the anticipated traffic within an acceptable time frame or interval, and which will carry all materials requiring vertical movement.

b. Traffic Flow.

(1) Numerous traffic tests and studies have determined that, for most buildings other than hospitals, medical buildings, clinics, and legal service buildings, there are three peak periods.

(a) Morning-in peak, when building is being filled with tenants.

(b) Noon or two-way traffic period during which there is heavy traffic up and down simultaneously.

(c) Night-out, when building is emptied at the end of the day.

(2) For hospitals, medical buildings and clinics only the two-way period need be considered, as traffic during the morning-in and the night-out peaks is never as heavy as the two-way traffic when patients are coming to and leaving the doctors' offices or clinics, or when materials, food, patients, visitors and staff are moving during normal hospital operation.

c. Intervals. Interval is defined as the time between elevators leaving the main floor to distribute passengers.

(1) For multistory diversified office buildings the acceptable 5-minute average intervals, while elevators are carrying the anticipated demand capacity, are:

(a) Morning-Up Peak. Thirty second maximum.

(b) Two-Way Peak. The acceptable average interval during the two-way noon peak is 40 seconds.

(c) Night-Out. Interval will be equal to or shorter than for morning-up peak. Should be able to empty building in 20 to 25 minutes.

(2) For hospitals, consider only the two-way peak. Intervals of 35 to 40 seconds are acceptable.

d. Demand.

(1) Morning-In Peak. Elevators should be able to carry one-eighth (12-1/2 percent) of the population, above the main floor, with average intervals noted above. Single-purpose buildings may develop higher peaks. Such buildings require careful and thorough study and analysis. Buildings housing service personnel often have special criteria, i.e., more intensive occupancy and a longer permissible average interval.

(2) Two-Way Peak. Elevators should be able to carry 15 percent of the population, part up and part down, with the average intervals noted above. For single purpose buildings a higher peak to 20 percent may develop.

3. ANALYSIS. Provide a comprehensive traffic analysis to justify the quantity, size, speed, and type of elevators required for the project based on the above criteria. Detailed studies and calculations may be obtained from the text Vertical Transportation, 2nd Edition, by George R. Strakosch.

Part 4. ELEVATOR COMPONENTS

1. PASSENGER ELEVATOR CAR ENCLOSURES.

a. General. Cars should have a single entrance whenever possible. Rear openings and right angle openings are special but available at additional cost.

b. Car. Car enclosures should consist of a 14-gauge steel shell at sides and rear from floor to canopy, with entrance returns and fascia of stainless steel or bronze, and a 12-gauge steel canopy with a hinged emergency exit normally openable only from the top of the car.

c. Lighting. Fluorescent lighting with protective lenses is recommended. Light intensity at handrail height, 20 footcandles. Provide minimum 8 feet clear under ceiling. Car lighting in hospitals and brigs, including emergency lighting, should be vandal resistant and resistant to accidental damage.

d. Finishes. Interior treatment is an architectural function and should be governed by utility, durability, and appearance.

(1) Recommended interior treatments for office building and other passenger elevators include plastic laminate applied to walls, removable panels with edges trimmed and faced with plastic laminate, stainless steel, patterned bronze, or rigidized stainless sheets. Car interiors must be fire retardant, see Rule 204.2a, ASME/ANSI A17.1.

(2) Hospital vehicle elevators often use stainless steel wainscoting to handrail height, with plastic laminate applied to steel above the wainscot. The use of 14-gauge rigidized stainless steel for side and rear panels using down lights in the canopy is not vulnerable to damage and is excellent for vehicle elevators.

(3) Shop buildings, barracks, clinics, and medical buildings use simple steel cars or cars similar to office buildings. Rigidized stainless steel construction similar to hospital vehicle cars is resistant to rough usage and may be considered.

(4) Brigs may require separate compartments for prisoners.

e. Doors. Car doors should be hollow metal faced with stainless steel, bronze, or plastic laminate. Center-opening doors with continuous neoprene astragals.

f. Miscellaneous Details. Provide:

(1) Handrails: 32 inches from floor.

(2) Emergency lighting unit accessible for testing.

(3) Ventilation by means of two-speed fan mounted on top of car canopy. Use quiet operating exhaust fan or blower on sound-isolating neoprene mount. Provide manual controls in car operating station.

(4) Hinged emergency exit, open from top of car only.

(5) Extruded white or yellow bronze car thresholds. Arrange platform to receive carpet or tile. Provide vinyl or rubber tile or car-pet.

(6) Telephone compartment or intercom or both.

(7) Pad hooks and protective pads.

2. FREIGHT ELEVATOR CAR ENCLOSURES.

a. Car. Enclosures shall be 14-gauge solid metal at sides and rear from floor to canopy. Provide a solid metal car top with an emergency exit openable only from the top of the car.

b. Car Gates: Car gates shall be vertical lifting. Car gates shall be at least 6 feet high.

(1) Car gates shall preferably be single section, but may be two section if there is a low headroom problem.

(2) Provide each power-operated vertical lifting car gate with a safety reversing edge and sequence door operation. Each car gate must be provided with contact inaccessible from the floor.

(3) Vertical lifting car gates may be wire mesh, perforated iron or similar material in a structural frame. All car gates must meet the requirements of Rule 204.4, ASME/ANSI A17.1.

(4) All vertical lift car gates should be power-operated. For elevators of light and intermittent service with gates less than 6 feet wide, manual operation may be considered.

c. Car Operating Station. Recess car station in side panel to avoid damage to operating buttons.

d. Bumpers. For Class B or C loading use heavy hardwood bumpers (3 inches by 12 inches) on car enclosure to avoid damage by vehicles. Allow for width of bumpers in basic design. Reinforce car sides.

3. CAR FRAMES AND PLATFORMS. Car frames and platforms must be designed to resist the actual loads used, without appreciable distortion or deflection. ASME/ANSI A17.1 establishes engineering criteria for platform and car frame design and also lists the usual methods of loading.

a. Car Frame. The car frame (sling) is the supporting frame which carries the platform. It is provided with top and bottom guide shoes and the hoisting ropes or hoist rope sheaves or the hydraulic plunger are attached to the car frame.

b. Platforms. Platforms are constructed of all steel or with a steel frame and wood flooring. The type of final flooring used depends upon the service requirements.

c. Guide Shoes.

(1) Use roller guide shoes for passenger elevators with spring or rubber backed rollers and neoprene or similar tires.

(2) For freight elevators use either flexible or solid guide shoes, whichever is compatible with the loading condition. Use 6- to 10-inch long nonferrous gibs designed to operate with minimum lubrication.

(3) Passenger and freight elevators with roller guides should be accurately balanced with a maximum shoe pressure of 30 psi.

4. ELEVATOR ENTRANCES.

a. Passenger Elevators. Entrances shall be horizontal sliding and shall include Underwriters Laboratories labels with fire rating in compliance with ASTM E152-81, Methods of Fire Tests of Door Assemblies. They may be single-sliding, two-speed, three-speed, center-opening, or two-speed center-opening.

(1) Doors and Frames. Materials and finishes for doors and frames are architectural details but utility, durability, ease of maintenance, as well as first cost, should guide the selection.

(a) For durability, minimum maintenance, and resistance to vandalism, stainless steel, either No. 302 with No. 4 finish or rigidized in various patterns, is the best material.

(b) Bronze or aluminum, regardless of finish, are easily damaged and cannot be successfully repaired, therefore should not be used.

(c) Furniture steel, with baked enamel or acrylic finish, is attractive but is readily scratched and damaged, requiring repainting.

(d) The first cost of stainless steel entrances is greater than baked enamel, but total cost over a period of years should be less.

(2) Power Operation of Doors.

(a) All passenger elevators should use power-operated car and hoistway doors opened and closed by a master door operator mounted on the car frame.

(b) Provide horizontal infrared type photo cell door control (light rays) for all automatic elevators, between safety edge and car sill. Use two solid state rays, 5 inches and 29 inches from floor.

(c) Provide circuit to disconnect light ray if it is obstructed or fails to operate, and to allow operation with safety edge protection only. A loud buzzer shall sound while doors are closing at reduced speed.

(d) Interruption of light ray or operation of safety edge shall cause the doors to reverse and reopen. Door travel shall be 1-1/2 inches maximum before reversing.

b. Freight Elevators. Vertical biparting or vertical lift counter-balanced doors are used for freight elevators which carry only freight, plus the attendant. They provide full width openings and can readily be made higher than 7 feet if necessary.

(1) Doors should be the full width of the inside of platform, and 4 inches to 6 inches higher than highest objects to be carried.

(2) Steel door bucks to support door guides and full width steel sills at openings should be in the miscellaneous metal work, not in elevator work. For walls other than concrete extend bucks from floor to beam above. For concrete walls imbed steel plate or angle in wall above opening to support door guides. It is not advisable to fasten guides to concrete.

(3) Power Door Operation. Doors shall open automatically and close by constant. pressure on door-close button. Door operators should open and close doors at 1 ft/sec.

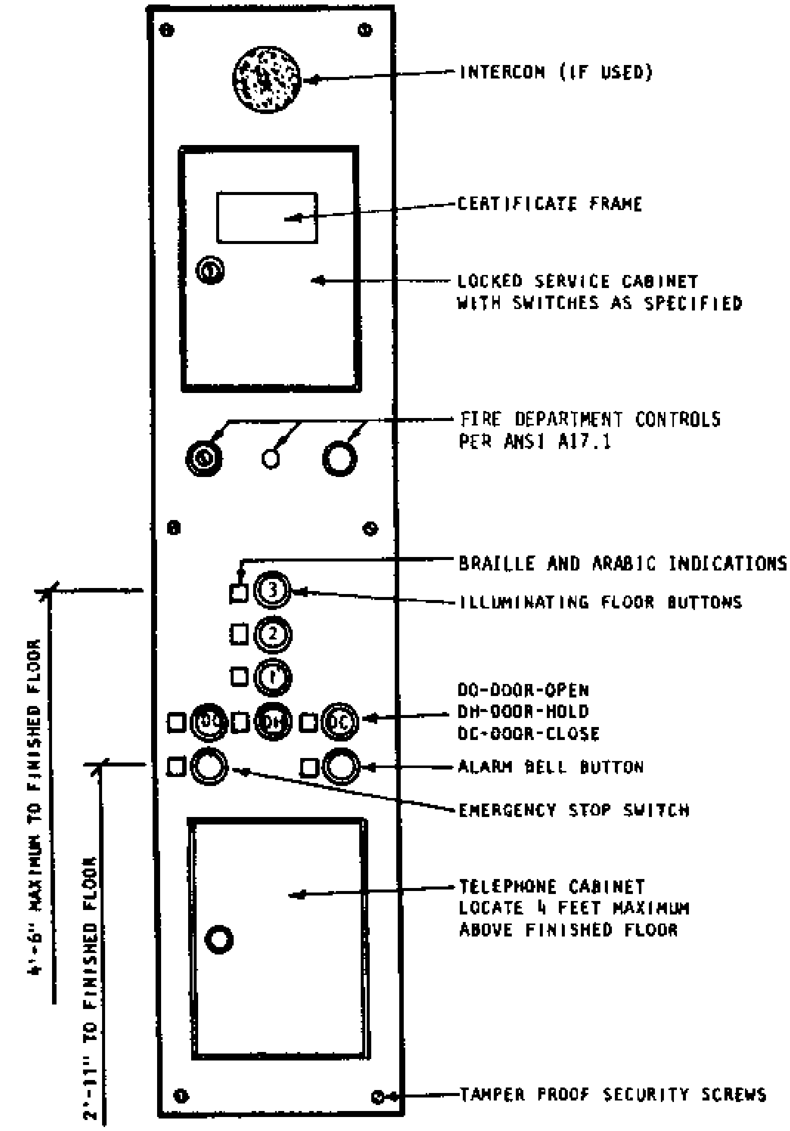
5. OPERATING AND SIGNAL FIXTURES.

a. Operating Fixtures, Passenger and Freight Elevators. Include one or two in-car operating stations used by passengers to register their floor calls. One or more hall button risers are used to register hall calls. Car fixtures also contain other buttons and switches used for operating functions, as well as a means of communication, either a telephone or an intercom system or both.

(1) Passenger Elevator Car Stations.

(a) Use one car operating station for single or two car installations where traffic is moderate, such as barracks, shops, clinics, or small office buildings (see Figure 3).

(b) Use two stations for busy elevators in office buildings and for hospital elevators. Two stations are a great convenience for heavily loaded elevators in any building (see Figure 4).



NOTES:

A. TELEPHONE AND SERVICE CABINETS MAY BE INSTALLED AS SEPARATE UNITS IN LIEU OF BEING INTEGRATED INTO CAR OPERATING PANEL FACEPLATE.

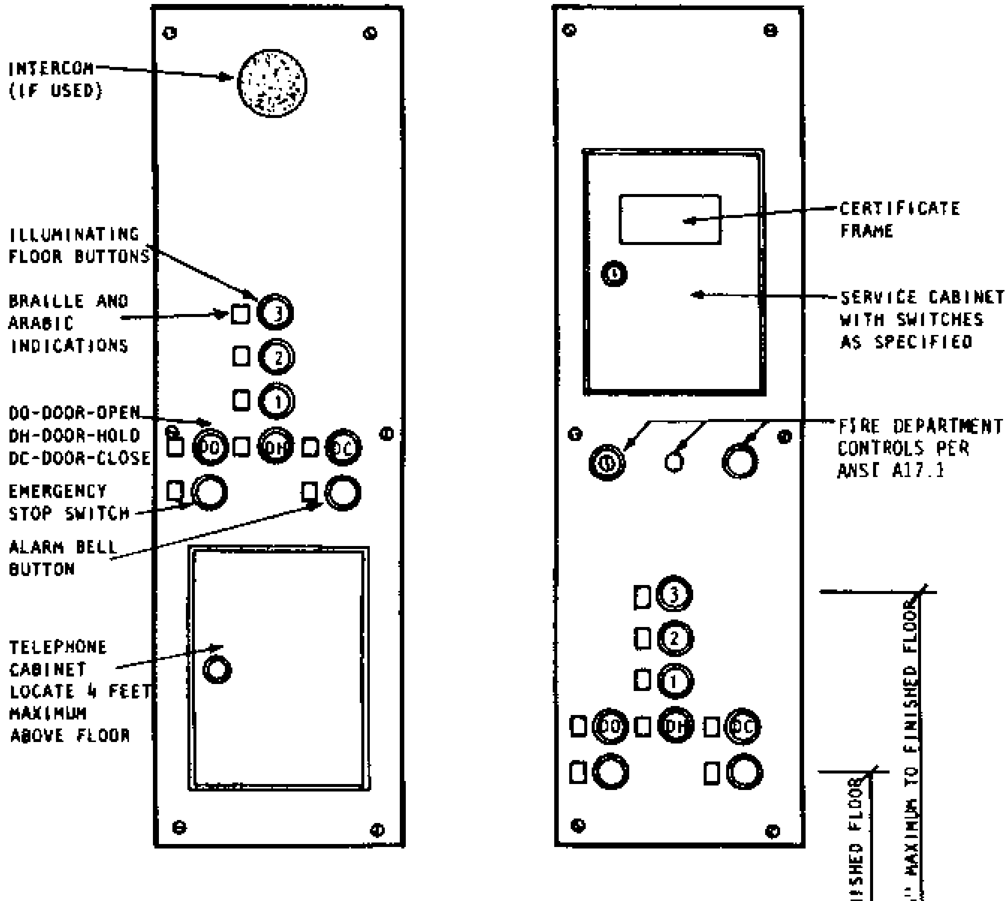
B. FOR FOUR OR MORE FLOORS USE TWO ROWS OF ILLUMINATING FLOOR BUTTONS.

C. ALL FACEPLATES SHALL BE 1/8 INCH THICK MATERIAL WITH EDGES RELIEVED.

D. ALL DEVICES MAY BE INCORPORATED INTO HINGED FRONT RETURN PANELS IN LIEU OF SEPARATE FACEPLATES.

E. PROVIDE ALL HANDICAP REQUIREMENTS PER ANSI A17.1.

Figure 3
Single Car Operating Panel



NOTES:

A. TELEPHONE AND SERVICE CABINETS MAY BE INSTALLED AS SEPARATE UNITS IN LIEU OF BEING INTEGRATED INTO CAR OPERATING PANEL FACEPLATE.

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D. ALL DEVICES MAY BE INCORPORATED INTO HINGED FRONT RETURN PANELS IN LIEU OF SEPARATE FACEPLATES.

E. PROVIDE ALL HANDICAP REQUIREMENTS PER ANSI A117.1.

Figure 4
Two Car Operating Panels

(c) Stations may be flush-mounted with separate faceplates or may be integrated in hinged front return car panels.

(d) Car Station Components. A single car station should contain the following:

(1) Door-open, door-close buttons.

(2) Door-hold buttons, When required (used primarily in hospital vehicle elevators).

(3) One illuminating, operating button per floor. For front and rear openings at a floor, provide two floor buttons marked "F" and "R" for operating door-open, close and -hold buttons.

(4) Emergency stop switch, toggle type or pull-to-stop.

(5) Alarm bell button with bezel or shield.

(6) Fire key switch and sign.

(7) Fireman's phone jack (when required).

(8) Key switches to lock out floors when required for security.

(9) Hospital emergency commandeering service key switch, When specified.

(10) A telephone cabinet or provision for intercom system or both.

(11) A locked service cabinet with light and fan switches, key operated inspection switch, independent service switch, light ray cutout switch, convenience outlet, spare switches, and all others specified.

(e) Provide Braille and Arabic designations for all stations located at the left of the floor buttons, door operating buttons, and all other operating buttons and switches in accordance with ANSI A117.1.

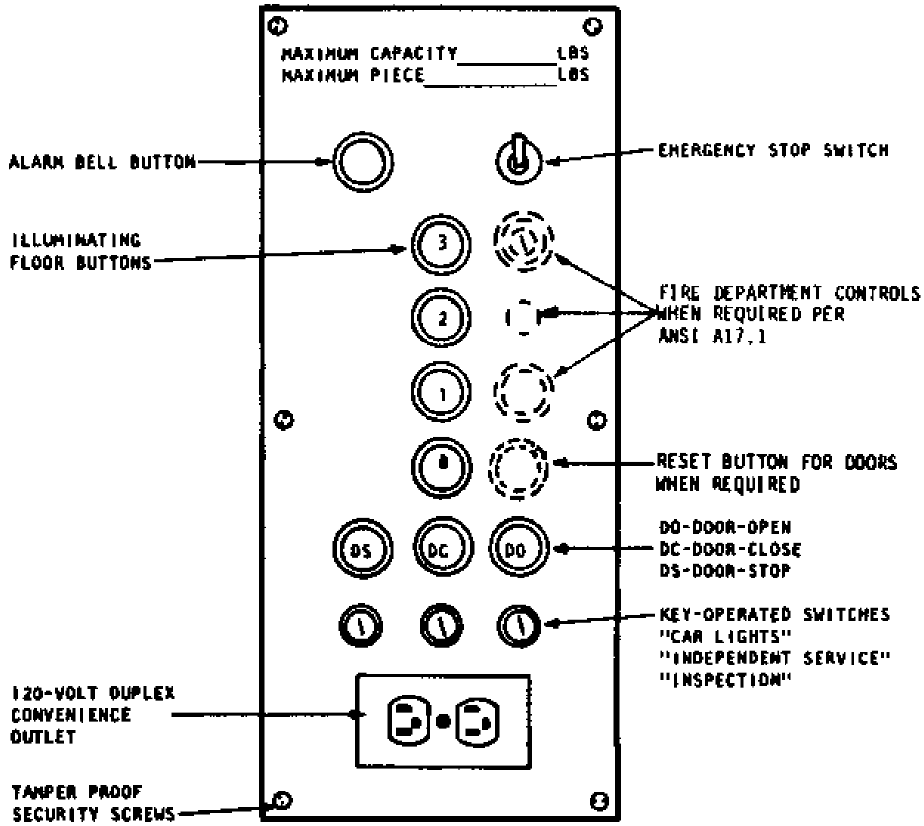
(2) Freight Elevator Car Stations.

(a) For freight elevators use a single car station with a single faceplate, as exhibited by Figure 5. A single station is usually sufficient except for long cars with reverse openings, for which a second station is convenient and desirable.

(b) If a telephone or intercom is required, integrate in car station or provide a separate cabinet.

(3) Hall Buttons.

(a) Use illuminated type with minimum 1-inch diameter buttons.



NOTES:

A. PROVIDE SEPARATE TELEPHONE CABINET OR INTERCOM STATION PER ANSI A17.1 RULE 211.1.

B. ALL FACEPLATES SHALL BE 1/8 INCH THICK MATERIAL WITH EDGES RELIEVED.

Figure 5
Freight Car Operating Panel

(b) Locate hall buttons 42 inches vertically above floor to centerline (see Figure 6).

(c) One riser may be used for three- or four-car groups in line, although two risers are preferred for four cars.

(d) If elevators are located on opposite sides of a corridor, provide a set of buttons for each side.

(e) For freight elevators with motorized biparting doors, include the door operating buttons in the same faceplate as the call buttons.

(f) Readouts, to indicate the location of the car, are often included in the hall station.

b. Signal Fixtures. Passenger Elevators. The purpose of signals is to indicate to passengers the location and movement of a car or cars (hall and car position indicators) or to alert waiting hall passengers to the approach of the car and to indicate the direction in which it will next travel (hall lanterns), see Figure 6.

(1) Car Position Indicators.

(a) Use position indicators, including direction arrows in car over door, for three or more floors. Minimum one inch size of numerals and arrows.

(2) Car Direction Indicator.

(a) Use car direction indicators in car entrance columns in lieu of hall lanterns for single cars or for light service two and three car groups. Minimum size 2-1/2 inch arrows with gongs or tone generators. For center-opening doors use two indicators each car. For single-sliding or two-speed use one indicator in strike jamb.

(b) Gongs or tone generator should sound once if car will go up next, twice if it will go down next.

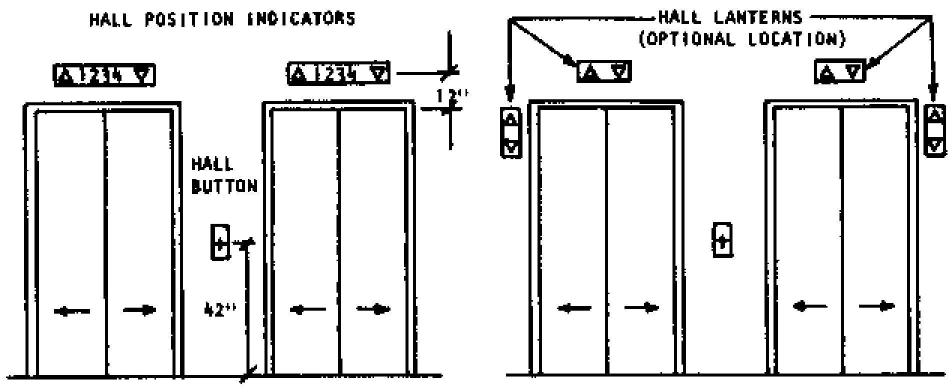
(c) A signal of this type meets requirements for the handicapped but is not as efficient as outside hall lanterns since no advance signal can be provided and the lantern is not visible until the car door is open.

(3) Hall Lanterns. Single at terminals, up-down at typical floors. Lanterns illuminate green for up, red for down.

(a) Use for two or more car groups at all floors or preferably at typical floors with hall position indicators at lobby.

(4) Hall Position Indicators.

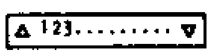
(a) Multilight hall position indicators with direction arrows at all floors are excellent for one-, two-, or three-car groups but are costly. Alternately, for two- or three-car groups, use indicators at main floor and hall lanterns at typical floors.



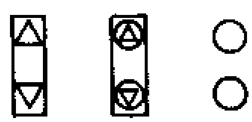
HALL BUTTON-TYPICAL LOCATION AT ALL FLOORS.

HALL POSITION INDICATOR-LOCATE AT MAIN LOBBY LEVEL OR AT ALL FLOORS. HALL LANTERNS MAY BE COMBINATED WITH POSITION INDICATOR.

HALL LANTERNS-LOCATE AT ALL FLOORS.



CAR OR HALL POSITION INDICATOR



HALL LANTERNS

HALL POSITION INDICATOR WITH LANTERNS

NOTES:

A. USE ONE INCH MINIMUM HIGH INDICATIONS FOR POSITION INDICATORS.

B. USE 2-1/2 INCH MINIMUM INDICATIONS FOR HALL LANTERNS.

C. USE HALL LANTERNS WITH GONGS THAT SOUND ONCE FOR UP DIRECTION AND TWICE FOR DOWN DIRECTION.

D. HALL LANTERN LENS COLOR SHALL BE GREEN FOR UP DIRECTION AND RED FOR DOWN DIRECTION.

Figure 6
Operating and Signal Fixtures

(b) Hall lanterns may be added to indicators, thus avoiding use of car direction indicators.

c. Miscellaneous Operating and Signal Fixtures.

(1) If travel above main floor exceeds 75 feet, check local building codes for life safety requirements which may require a monitor panel in a control area.

(2) Tamperproof car and hall buttons and fixtures are available if vandalism is anticipated.

(3) Explosion proof and moisture proof fixtures are available if conditions warrant their use.

(4) For security, key operation may be provided to lock out car calls to various floors and in hall stations. Optionally, magnetized card control, which is less vulnerable to misuse than key control, should be used.

(5) Monitor Panels. Monitor panels are often furnished in an engineer's control room as part of the life safety program for office buildings, hospitals, or brigs and usually contain the following:

(a) Readouts showing position and motion of each car.

(b) Jewels indicating car and hall calls.

(c) Jewels indicating operation of stop switch or alarm bell button.

(d) Jewels to monitor various operating and security functions.

(e) Fire system controls.

(f) Communication system.

(6) Monitor panels can become large, complex, and costly and should only be used when required. Functions to be monitored should be kept to those essential to meet the life safety program.

Part 5. WIRING AND LIGHTING

1. GENERAL. All conduit, raceways, and wiring must comply with the NFPA No. 70-84, National Electrical Code, and ASME/ANSI A17.1. Types and sizes of wiring and supports shall conform to NFPA No. 70, Article 620.

a. Power Supply. Feeders, mainline disconnect switches, and auxiliary circuits for signal, telephone, and freight door operation are in the electrical, not the elevator, work.

b. Machine Rooms and Pits.

(1) Provide minimum 10 footcandles, maximum 15 footcandles at floor level in the machine room, and 10 footcandles in the pit.

(2) Include convenience outlets in each area. Provide Ground Fault Interrupter (GFI) -protected and wet-protected outlets in pit areas.

Part 6. HOISTWAYS, PITS, MACHINE ROOMS

1. HOISTWAYS. Rules for construction of hoistways vary. ASME/ANSI A17.1 requires enclosed, fire-resistive hoistways. The fire-resistive ratings shall be as required by national or local building codes.

a. Enclosures. Enclosure ratings shall be 2-hour rated unless otherwise authorized by local building codes; hoistway entrances shall be 1-1/2-hour rated.

(1) No more than four elevators are permitted in a single hoistway, and in some localities only three are allowed. ASME/ANSI A17.1 states that local codes govern in this respect.

(2) No windows shall be provided in elevator hoistway

b. Framing. Adequate supports for car and counterweight guide rail brackets must be provided for each hoistway.

(1) For areas where no earthquake protection is required provide, as a minimum, structural supports at each floor level, close to the perimeter of the hoistway.

(2) If floor heights exceed 14 feet, intermediate supports are required to meet criteria in ASME/ANSI A17.1.

(3) For Zone 3 and Zone 4 seismic areas, establish seismic loads and provide supports which have a maximum deflection of 1/4 inch under seismic loading.

c. Nonelevator Related Equipment. Conduit, wiring, ducts not used for beating or cooling hoistway, feeder wiring, and sprinkler risers are not allowed in elevator hoistway.

d. Venting Hoistways. ASME/ANSI A17.1, Rule 100.4 requires that hoistways be vented in accordance with local or national building codes. Local codes vary widely in their requirements, but the nationally used codes are generally similar. For example, some codes require natural ventilation of 3 ft^2 or 10 ft^2 while others require hoistway pressurization.

2. PITS. Every elevator must have a pit with a minimum depth as required by ASME/ANSI A17.1.

a. Water Removal. Pits should be dry and level. A sump and cover, with provision for a portable sump pump, is recommended for removal of water in the pit.

b. Access. Access to pits shall be by ladder from the lowest landing or, if pit extends a sufficient distance below the lowest stop, access is allowed through a door at the pit bottom.

(1) Ladders shall meet requirements of ASME/ANSI A14.3, Safety Requirements for Fixed Ladders.

(2) For deep pits, access to oil buffer mist be provided for servicing.

(3) Provide pit screens between adjacent elevators where required by ASME/ANSI A17.1.

(4) Walk-in access doors to deep pits must be self-closing and self-locking.

3. ELEVATOR MACHINE ROOMS.

a. Clear Height. All machine rooms must have a minimum of 7 feet clear height and be large enough to contain all operating equipment with legal clearances. A minimum 7 feet 6 inches or 8 feet high is preferable to allow a satisfactory wiring installation.

b. Nonelevator Related Equipment. No equipment, pipes or ducts not directly related to elevator equipment shall be installed in machine rooms. Heating and cooling equipment for machine room only may be installed in machine room. No one except a trained elevator engineer or mechanic is allowed to enter an elevator machine room. Passageways through a machine room for any purpose are prohibited unless a separate area is screened off. (Check prevailing codes for possible exceptions.)

(1) Do not install a skylight over a machine room or hoistway.

(2) Height of sheave spaces and secondary levels and access from the machine room to these spaces shall be as required by ASME/ANSI A17.1.

c. Enclosures. Machine room walls must carry the fire rating required by local codes. Doors should open out, be provided with closers and locks, and arranged so that they are never locked on the inside.

d. Access. Access to machine rooms and areas is governed by prevailing codes and should be safe and easy. Avoid travel across roofs or exposed areas.

(1) Vertical ladders may be used for a 3-foot maximum difference in elevation. For greater distances use stairs with 50 degree maximum.from horizontal.

e. Temperature. Ventilation and heating must be adequate as operation is inconsistent at very low or very high temperatures.

(1) Maintain temperature range from 40 degrees F minim m to 90 degrees F maximum by providing at least 10 CFK/HP of elevator motor.

(2) Gravity ventilation is not adequate. Use fans or pass air from general air conditioning systems through machine room.

(3) Verify beat release in Btu/h from elevator manufacturer and design ventilation accordingly.

(4) Variation of ventilation which relies upon manual operation of windows or fans is not acceptable.

f. Noise and Noise Control. Some operating noise from motors, generators, controllers, and machines must be expected, but should be held to a minimum.

(1) Noise is transmitted by air or through the structure.

(2) Airborne noise can be reduced by protecting the walls of the machine room and by adding ventilated covers to the elevator equipment noise source such as hydraulic pumping plants.

(3) Noise transmittal through the structure can be minimized by sound-isolating the noise producing components.

(4) Interior machine rooms for low-rise elevators in a high-rise building should be located remote from quiet interior spaces, when possible.

(5) Eliminating objectionable noises can upon occasion be difficult and is a problem for the acoustical engineer.

(6) For appropriate noise control measures see NAVFAC DM-3.10 and NAVFAC DM-1 series.

Part 7. ELEVATOR DESIGN EXAMPLES

1. GENERAL. This part will cover the study and design parameters of various types of elevators covering information needed by in-house disciplines such as structural, electrical, and mechanical engineers. The formula used are taken from the,elevator industry standards; however, some manufacturers may use other calculations to figure their loads based on their equipment weights distribution, and equipment efficiencies. The information contained in this part should be used as a guide for preliminary design only and is subject to change on each particular project depending on the successful contractor installing the equipment.

2. EQUATIONS. The following equations are used to determine various structural, electrical, and mechanical loads of elevator systems.

a. Structural Loads. Structural loads consist of buffer impact and cylinder impact loads at pit floor, machine room overhead loads at top of hoistway, and guide rail forces on hoistway framing.

(1) Buffer Impact Load at Pit Floor.

(a) Spring buffers for speeds up to 200 fpm.

EQUATION: $$R = 2W\left(1 + \frac{v^2}{2gs}\right) \qquad (1)$$

$P = R/2$ (on each of two buffers)

(b) Oil buffers for speeds over 200 fpm.

EQUATION: $$R = W \left(1 + \frac{v^2}{2gs}\right) \qquad (2)$$

$$P = 2R \text{ (on one buffer)}$$

where,

R = buffer reaction, lb
P = impact, lb
$g = 32.2$ ft/sec^2
s = buffer stroke, ft (see ANSI A17.1, Table 201.4a)
v = speed at impact, fps
W = weight of car plus rated capacity, lb

(2) Cylinder Load At Pit Floor For Hydraulic Elevators.

EQAUTION: $$P = 2W \qquad (3)$$

where,
P = Impact, lb
W = weight of car plus 115% of rated capacity plus combined weight of cylinder, plunger, and oil.

(3) Machine Room Overhead Loads. Total load at top of hoistway for traction elevators.

EQUATION; $$TL = 2\ (C+L+CWT+TC+RH)+M+MB+FL \qquad (4)$$

where,

TL = total load on hoistway, lb
C = weight of car, lb
L = rated capacity, lb
CWT= weight of counterweight, lb (car weight plus 40% of rated capacity).
TC = weight of traveling cables, lb
RH = weight of hoist ropes, lb
M = weight of machine, lb
MB = weight of machine beams, lb
FL = weight of floor slab, lb

(4) Guide rail forces on hoistway framing at each floor when elevator is level with landing and is being loaded.

(a) Passenger elevator loading condition.

EQUATION:

$$R1 = \frac{PE}{8H} \qquad (5a)$$

$$R2 = \frac{AP}{8H} \qquad (5b)$$

(b) General freight elevator class "A" loading condition.

EQUATION:

$$R1 = \frac{PE}{8H} \qquad (6a)$$

$$R2 = \frac{3AP}{16H} \qquad (6b)$$

(c) Motor vehicle freight elevator class "B" loading condition.

EQUATION:

$$R1 = \frac{3}{8} \times \frac{P}{H}(E-96) \qquad (7a)$$

$$R2 = \frac{3}{8} \times \frac{AP}{DH}(D+E-96) \qquad (7b)$$

(d) Industrial truck freight elevator calss "C" loading condition.

EQUATION:

$$R1 = \frac{1}{4} \times \frac{EP}{H} \qquad (8a)$$

$$R2 = \frac{9}{40} \times \frac{AP}{DH} \qquad (8b)$$

where,

R1 = horizontal force on face of guide rail, lb
R2 = lateral force on side of guide rail, lb
P = weight of car plus rated capacity, lb
D = distance between guide rails, in (assume E + 7 in)
E = inside width of car enclosure, in

A = distance from front of car to center of guide rails, in (assume center of car front to back)
H = vertical distance between center line of guide shoes, in (assume cab height plus 42 in)

b. Electrical Loads Three-phase alternating current will be required for All elevators. Feeders and fused disconnect switches or circuit breakers must Be sized for the elevator horsepower, full load running current and full load Accelerating current.

(1) Traction Elevator Horsepower.

EQUATION:

$$HP = \frac{.60 \times c \times V}{33{,}000 \times eff.} \qquad (9)$$

where,

HP = horsepower
c = rated capacity, lb
v = speed, fpm
eff= efficiency of elevator machine (use .60% for speeds up to 400 fpm and .75% for speeds over 400 fpm)

(2) Hydraulic Elevator Horsepower.

EQUATION:

$$HP = \frac{c \times v}{33{,}000 \times .80} \qquad (10)$$

where,

HP = horsepower
c = weight of car plus rated capacity, lb
v = speed, fpm

(3) Full Load Running Current. Refer to Table 430-150 of the National Electrical Code (NEC) to determine full load running current for the horsepower required and the voltage used.

(4) Full Load Accelerating Current.

EQUATION;

$$FLA = FLR \times 2.5 \qquad (11)$$

where,

FLA = full load accelerating current, A
FLR = full load running current, A

c. Mechanical Loads. Provisions must be made to heat, ventilate, or cool the elevator machine rooms. The following formulae are used to determine the average heat generated by the elevator equipment. Together with this heat release, the construction of the machine room and the adverse outside temperatures of the project location, determine the amount and type of ventilation required to maintain the machine room temperature between 40 deg. F and 90 deg. F.

(1) Traction Elevators.

EQUATION:

$$H = 5000 + (0.15)\,(c)\,\left(\frac{v-250}{2} + 250\right) \qquad (12)$$

where,

H = heat release, Btu/h
c = rated capacity, lb
v = speed, fpm

(2) Hydraulic Elevators.

EQUATION:

$$H = 382 \times HP \qquad (13)$$

H = heat release, Btu/h
HP = horsepower

3. EQUIPMENT WEIGHTS. The following represents weights for certain equipment used in the preceding formulae. These figures are to be used as a guide only and should be verified with the successful contractor installing the equipment.

a. Weight of Car.

(1) Hydraulic Elevators. Use 120 lb/ft^2 of inside net area of car enclosure.

(2) Traction Elevators. Use 150 lb/ft^2 of inside net area of car enclosure.

b. Weight of Counterweight. Weight of car plus 40% of rated capacity.

c. Combined Weight of Cylinder. Including plunger cylinder head and oil with car at top landing. Use 100 pounds per foot of elevator travel plus 250 pounds.

d. Weight of Traveling Cable. Use one pound per foot of elevator travel.

e. Weight of Hoist Roves. Use six pounds per foot of elevator travel.

f. Weight of Machine. Geared machine up to 400 fpm use 3500 pounds; gearless machine over 400 fpm use 5000 pounds.

g. Weight of Machine Beams. Use 30 pounds per foot times the front to back dimension of the hoistway times two machine beams for each elevator.

h. Weight of Floor Slab. Use 150 pounds per foot times the length of each machine beam.

4. DESIGN EXAMPLES.

a. Hydraulic Passenger Elevator. Assume 3500-pound capacity at 125 fpm serving four floors with a travel of 36 feet. Car inside dimensions of 80 inches wide by 63 inches deep by 96 inches high.

(1) Structural Loads.

(a) Buffer impact, Equation (1).

$$R = 2\ (3500 = 4200) \times \left(1 + \frac{2.083^{2}}{2 \times 32.2 \times .333}\right)$$

$$= 15{,}400 \times (1 + .2023)$$

$$= 18{,}515 \text{ lbs.}$$

$$P = R/2$$

$$= 9{,}258 \text{ lbs. on each of two buffers.}$$

(b) Cylinder head load, Equation (3).

$$P = 2\ (4200 + 4025 + 3850)$$

$$= 24{,}150 \text{ lbs.}$$

(c) Guide rail forces, Equations (5a) and (5b).

$$R1 = \frac{(3500 + 4200)\ (80)}{(8)\ (138)}$$

$$= 558 \text{ lbs.}$$

$$R2 = \frac{(32)\ (3500 + 4200)}{(8)\ (138)}$$

$$= 223 \text{ lbs.}$$

(2) Electrical Loads. 480 VAC 3 phase power supply.

(a) Horsepower, Equation (10).

$$HP = \frac{(3500 + 4200)\ (125)}{(33,000)\ (.80)}$$

$$= 36.4 \text{ (use 40 HP)}$$

(b) Full load running current from Table 430-150 NEC; FLR = 52A.

(c) Full load accelerating current, Equation (11).

$$FLA = (52)\ (2.5)$$

$$= 130A$$

(3) Mechanical Loads, Equation (13).

$$H = (382)\ (40)$$

$$= 15,280 \text{ Btu/h}$$

(4) Obtain hoistway size, machine room size, pit depth and overhead clearance from NEII, Vertical Transportation Standards.

b. Electric Traction Passenger Elevator. Assume 3500-pound capacity operating at 350 fpm serving four floors with a travel of 36 feet. Car inside dimensions of 80 inches wide by 63 inches deep by 108 inches high.

(1) Structural Loads.

(a) Buffer impact, Equation (2).

$$R = (5250 = 3500)\ 1 + \left[\frac{5.833^{2}}{2\ (32.2)\ (.6875)} \right]$$

$$= 8750\ (1 + .7684)$$

$$= 15,473 \text{ lb}$$

$$P = 2\ (15,473)$$

$$= 30,946 \text{ lb on one buffer}$$

(b) Machine room overhead load, Equation (4).

$$TL = 2\ (5250+3500+6650+36+216)+3500+450+2250$$

$$=2\ (15,652) + 6200$$

$$=31,304 + 6200$$

$$=37,504\ lb$$

(c) Guide rail forces, Equations (5a) and (5b).

$$R1 = \frac{(3500 + 5250)\ (80)}{(8)\ (150)}$$

$$= 583\ lb$$

$$R2 = \frac{(32)\ (3500 + 5250)}{(8)\ (150)}$$

$$= 233\ lb$$

(2) Electrical Loads. 480 VAC 3 phase power supply.

(a) Horsepower, Equation (9).

$$HP = \frac{(.60)\ (3500)\ (350)}{(33,000)\ (.60)}$$

$$= 37.12\ (\text{use 40 HP})$$

(b) Full load running current from Table 430-150 NEC; FLR = 52A.

(c) Full load accelerating current, Equation (10).

$$FLA = (52)\ (2.5)$$

$$= 130A$$

(3) Mechanical Loads, Equation (12).

$$H = 5000 + (.015)\ (3500)\ \frac{(350 - 250 + 250)}{2}$$

$$= 20,750\ Btu/h$$

(4) Obtain hoistway size, mechanical room size, pit depth, and overhead clearance from NEII, Vertical Transportation Standards.

c. Hydraulic Freight Elevator. Assume 50,000-pound capacity class "A" loading operating at 50 fpm serving four floors with a travel of 36 feet. Inside car dimensions of 120 inches wide by 180 inches deep by 108 inches high.

(1) Structural Loads.

(a) Buffer impact, use Equation (1).

(b) Cylinder load, use Equation (3).

(c) Guide rail forces, use Equations (6a) and (6b).

(2) Electrical Loads.

(a) Horsepower, use Equation (10).

(b) Full load running current, from Table 430-150 NRC.

(c) Full load accelerating current, use Equation (11).

(3) Mechanical Loads, use Equation (13).

(4) Layout Information, refer to NEII, Vertical Transportation Standards.

d. Electric Traction Service/Passenger Elevator. Assume 5000-pound capacity operating at 500 fpm serving eight floors and a travel of 84 feet. Inside car dimensions of 68 inches wide by 102 inches deep by 108 inches high.

(1) Structural Loads.

(a) Buffer impact, use Equation (2).

(b) Machine room overhead load, use Equation (4).

(c) Guide rail forces, use Equations (5a) and (5b).

(2) Electrical Loads.

(a) Horsepower, use Equation (9).

(b) Full load running current from Table 430-150 NEC.

(c) Full load accelerating current, use Equation (11).

(3) Mechanical Loads, use Equation (12).

(4) Layout Information, refer to NEII, Vertical Transportation Standards.

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1. DEFINITION, CODE REQUIREMENTS, AND USE. A dumbwaiter is a hoisting and lowering mechanism with a car of limited capacity and size which moves in guides in a substantially vertical direction and is used exclusively for carrying material (see Figure 7).

a. Code Requirements. ANSI A17.1 requires dumbwaiters to meet the following.

(1) Maximum platform area 9 square feet.

(2) Maximum inside height 4 feet.

(3) Maximum capacity 500 pounds.

b. Use. Use for transporting food or materials without an attendant.

2. TYPES OF LOADING. Type of loading is determined by the material being moved and where the dumbwaiter stops in relation to floor level.

a. Counter Loading. May be manual or automatic load and unload where dumbwaiter stops at counter height. Use for transporting records, pharmaceuticals, small supplies, and other small items normally handled by hand.

b. Floor Loading. Use where roll-on carts are needed to transport materials.

3. TYPES OF OPERATION. Operation of dumbwaiters shall be multibutton call-and-send between all floors or central station dispatch.

a. Multibutton. Multibutton is used for general purpose dumbwaiters handling pharmaceuticals, small supplies, records, clean and dirty food carts, and where frequent trips between all floors are needed.

b. Central Dispatch. Central station dispatch is used when control of distribution is essential, such as food carts, supply carts, critical pharmacy supplies, mail, etc., when trips are initiated and terminated at a central point.

4. SIGNALS AND OPERATING FIXTURES.

a. Signals. Signals used include in-use lights, car-coming lights, car-arrival light, door-open buzzer, hall lanterns over doors, and gong or tone generators at nurses stations.

b. Operating Stations.

(1) For central station dispatch, provide station with buttons for each floor at central station, annunciator showing position of car and direction of travel, and car-arrival lanterns.

(2) Hall buttons for multibutton call-and-send include station at each floor with call button, dispatch button for all other floors, and car-coming light.

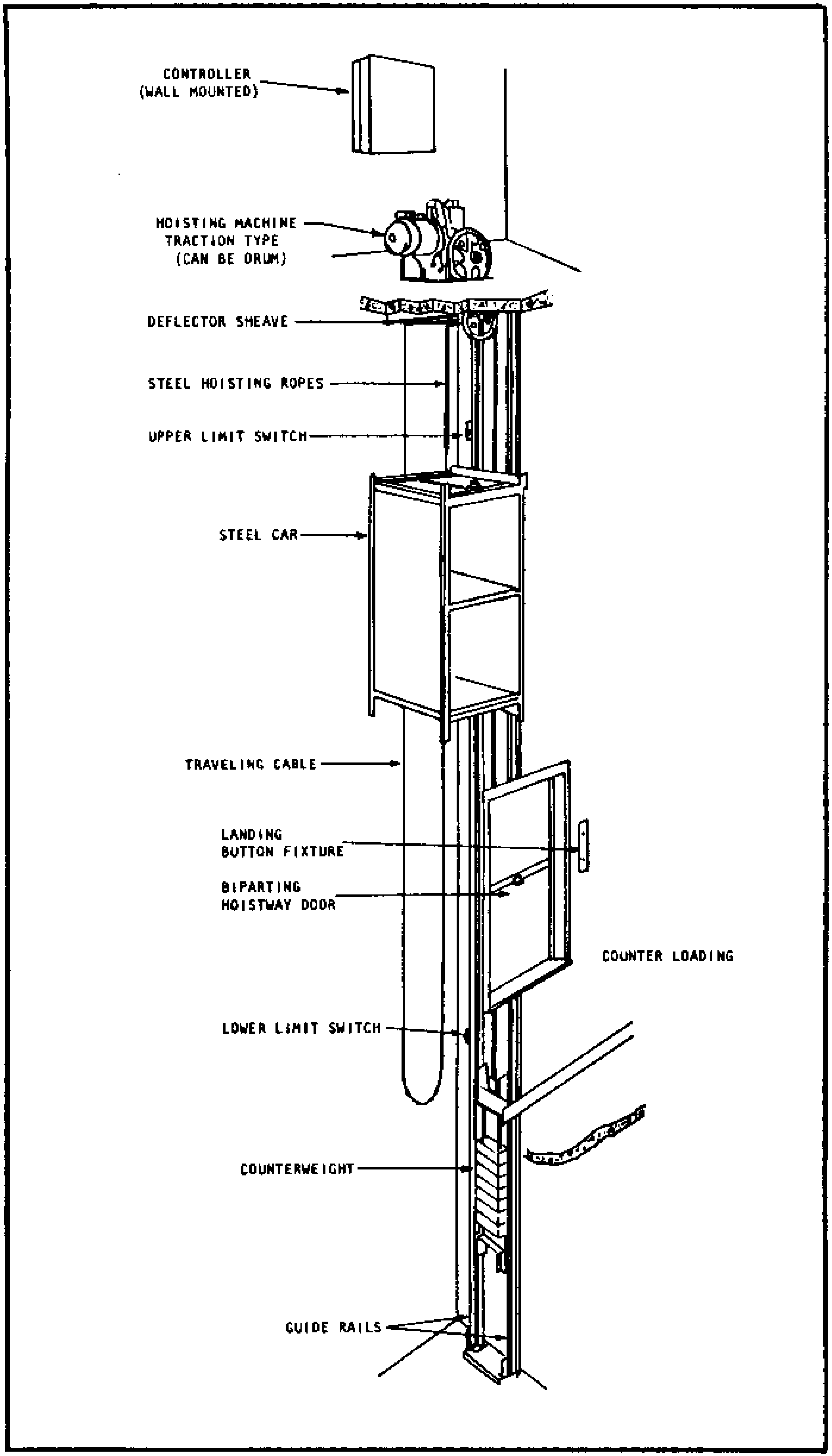

Figure 7
Typical Dumbwaiter

(3) For central station dispatch, provide button at each floor other than dispatch floor, to call for car by registering call on annunciator at central station.

5. MACHINES.

a. Drum Type. Use for short travels, slow speed, intermittent service. No counter-weights used. Maximum travel 30 feet; maximum speed 50 fpm.

b. Traction Type. Use for any travel and speeds to 350 fpm. Usual maximum speed 300 fpm.

c. Location. Traction or drum machines may be located overhead or below.

6. TYPE OF CONTROL.

a. Single-Speed Alternating Current Motors. Use for counter loading or may be used for floor loading with manual loading of carts. Do not use for automatic load and unload. Maximum speed 100 fpm.

b. Two-Speed Alternating Current Motors. Use for counter loading or manual floor loading for speeds to 100 fpm.

c. Generator Field Control. Use for any speed. Specify stopping accuracy of +/- 1/4 inch. Suitable for automatic load and unload, for floor loading or automatic discharge on tables,

7. ENTRANCES. Dumbwaiter entrances may be swing, horizontal slide, vertical lift, or biparting.

a. Assemblies. Entrances are provided complete with frames, struts, sills, and door panels, and include tamperproof interlocks, corridor side latches, and vision panels. Doors are preferably biparting. Second choice is vertical lifting.

b. Finishes. For hospitals always use stainless steel frames and insulated door panels with stainless steel on both sides. Stainless steel frames and sills are desirable for all dumbwaiters.

c. Size. Make one entrance wider and higher than others to allow removal of car, if necessary. Door width and height is the same as the clear inside car enclosure width and height.

d. Operation. Power door operation is mandatory for automatic load and unload either counter or floor loading and desirable for all floor loading dumbwaiters.

8. CAR ENCLOSURES.

a. Car. Use 14-gauge steel with 10-gauge bottom for floor loading. Use stainless steel for hospitals, kitchens, etc.

b. Shelves. Provide adjustable removable shelves for counter loading with manual load and unload.

c. Gates. Furnish contacted ear gates at all entrances. Power operation is preferred.

d. Guide Shoes. Provide heavy nonferrous guide shoes for cars and counterweights for quiet operation.

e. Lighting. Provide recessed car light.

9. PRECAUTIONARY FEATURES.

a. Automatic Load and Unload. For automatic load and unload equipment accurate stopping +/- 1/4 inch is essential. For floor loading, the floor in front of the dumbwaiter must be exactly level. Carts used for automatic load and unload must be accurately fabricated.

b. Safeties. If there is occupied space beneath a dumbwaiter hoistway and the rated load of the dumbwaiter exceeds 25 pounds, provide broken rope car and counterweight safeties without governors.

10. HOISTWAY EQUIPMENT AND ACCESS.

a. Machine Location.

(1) Overhead in hoistway or in machine room above.

(2) Below in hoistway for counter loading.

(3) Below adjacent for floor loading.

b. Access to Machines and Controller.

(1) Overhead location in hoistway. Provide contacted access panel and ladder per code.

(2) Below in hoistway. Provide contacted access panels.

(a) If machine is in hoistway, use wall-mounted controller in locked cabinet adjacent to top opening. Provide stop switch near machine room access.

(3) Separate machine room access as for elevators.

(4) Provide mainline disconnect switches and light switches adjacent to controller.

c. Guide Rails. Standard dumbwaiters often use light channel guides for car and counterweights. Use 8 pound per foot guide rails for automatic load and unload dumbwaiters.

d. Wiring. Wiring requirements are the same as for elevators.

Section 4: ESCALATORS

1. USE. Escalators are used for the movement of concentrated masses of people where the installation of escalators proves to be more economical than elevators.

2. RATED CAPACITIES. The rated capacity for the two commonly used escalator widths are 5000 persons per hour for a 32-inch escalator at 90 fpm, 6000 persons per hour for a 32-inch escalator at 120 fpm. 8000 persons per hour for a 48-inch escalator at 90 fpm and 9000 persons per hour for a 48-inch escalator at 120 fpm. Average loading is about 60 to 65 percent of the rated capacity. Escalator widths are measured at midpoint of the balustrade. Actual step width for a 32-inch escalator is 24 inches, and 40 inches for a 48-inch escalator.

3. APPLICATION. Escalators may be used for hospitals, clinics, office buildings, colleges, laboratories, and engineering offices as the main means or auxiliary means of transportation between frequently traveled floors.

4. SPEED. Escalator speeds are available at 90 fpm and 120 fpm. Two-speed escalators can be used at 90 fpm during of peak periods and at 120 fpm during busy periods.

5. SPACE CONSIDERATIONS. See Figure 8 and NEII, Vertical Transportation Standards, for escalator space requirements.

6. OPERATIONS.

Escalators shall be reversible. Direction can be changed by operation of key switch at top and bottom of escalator.

(1) Parallel escalators can both be operated up during predominantly up traffic, down for the reverse, and one up, one down for normal flow as in hospitals or training facilities.

(2) A single escalator can be used as a reversible unit, operating up or down as traffic dictates.

7. BALUSTRADES. Escalators may have conventional metal balustrades with metal-faced interior panels or with transparent glass interior.

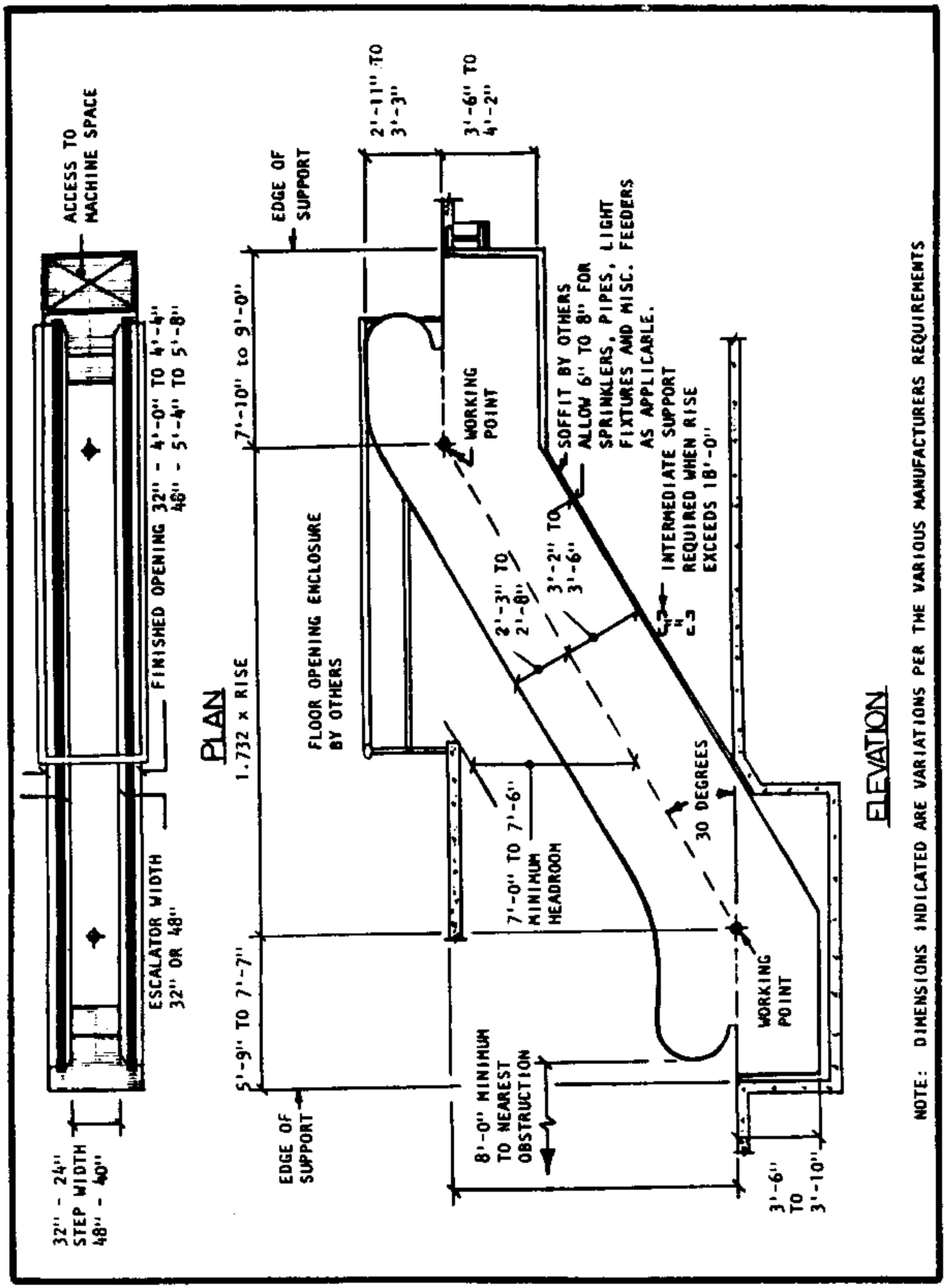

Figure 8
Escalator Space Requirements

8. DRIVING MECHANISM.

a. Conventional. Type of driving mechanism may be conventional with single machine in truss at top of escalator or externally at top for high travel.

b. Modular. Modular, with driving machines in truss every 20 to 25 feet down incline.

c. Advantages. For travels to about 25 feet, neither arrangement has any appreciable advantages, but for long travels the conventional drive requires a large machine and, for some manufacturers, a separate machine room, which requires a structure at the top of the escalator.

9. SUPPORTING STRUCTURE. Each escalator is contained within an individual truss, which is supported on beams provided in the building structure. Supports at the ends only, are adequate for vertical travels up to about 20 feet, beyond which intermediate supports are required.

10. CONSTRUCTION DETAILS.

a. Steps. Steps are provided with cleated treads and risers. Some manufacturers provide treads with a line of demarcation at front or rear. Recent designs by some manufacturers incorporate treads with steps. If tread is damaged, the entire step must be replaced.

b. Skirts. Skirts must be set accurately with reference to steps and clearance between step and skirt held to a minimum. ANSI A17.1 allows 3/16-inch maximum clearance between step and skirt.

c. Machine. Drive machines use worm gears and low-slip induction motors.

d. Controllers. Controllers shall include overload and reverse phase relays and be located in the truss machine area for conventional units. Controllers are in adjacent area for modular units.

e. Handrails. Handrails have steel inserts, with laminated canvas neoprene covers, and should operate at the same speed as the escalator. Inserts of contrasting color to indicate direction of travel are valuable.

f. Step Frame. Step frames shall be rigid and sound-isolated with two chain and two trailer wheels per step. Restrain rollers to ensure uniform tracking of steps.

g. Step Wheels. Step wheels are usually laminated canvas or neoprene.

11. OPERATING AND SAFETY DEVICES. ASME/ANSI A17.1 requires a key-operated starting switch at top and bottom of each escalator and also accessible emergency stop buttons with hinged guard at top and bottom. Lifting the guard shall ring an alarm bell.

a. Safety Devices. Safety devices shall be readily accessible for maintenance and resetting and in accordance with ASME/ANSI A17.1.

b. Machine Area and Pit. For machine area and pit, provide access doors with contacts and mainline fused disconnect switch in machine area.

c. Fault Finder. Recommend fault indicator and location device which indicates operation of any safety device.

d. Fire Protection. Provide wellway and truss fire protection per NFPA 101, Life Safety Code.

1. USE. Access lifts are primarily for the use of the handicapped in wheelchairs where ramps or other means of access are not practical.

2. INSTALLATION. These devices are not installed by elevator manufacturers but by specialty contractors, each with his particular design and standards which mist comply with ASME/ANSI A17.1.

a. Platform Lifts. Vertical wheelchair lifts are available for porch lifts, for stage lifts, for travels to about 7 feet 8 inches, and by one manufacturer for a one-floor travel (see Figure 9).

b. Stair Lift. Stair lifts are usually for residential use only. One type will negotiate a turn in a stair (see Figure 10)

3. TYPES. A number of manufacturers offer wheelchair lifts which fall into two main categories. Platform size is about 4 feet wide by 3 feet deep.

a. Hydraulic. Either direct plunger or a hydraulic piston which drives a mechanical lifting system.

b. Electric. Electric scissors type or direct electrical screw drive.

c. Special Lifts. Refer to DM-37.01-(Interim), Swimming Pools, for hydraulic-operated lifts used for access to swimming pools.

4. SPEED. Speed is slow, about 10 fpm.

5. CONTROL. Control is constant pressure. Release of operating bottom between floors causes car or stair climber to stop.

6. CAR ENCLOSURE. Car box is completely enclosed with a gate or door on car.

7. SAFETY. Safety devices include top and bottom limit switches, brake, car safety device, grounded electrical system keylock on controls, emergency stop, car door or gate with mechanical lock and electric contact, and nonslip floor on platform.

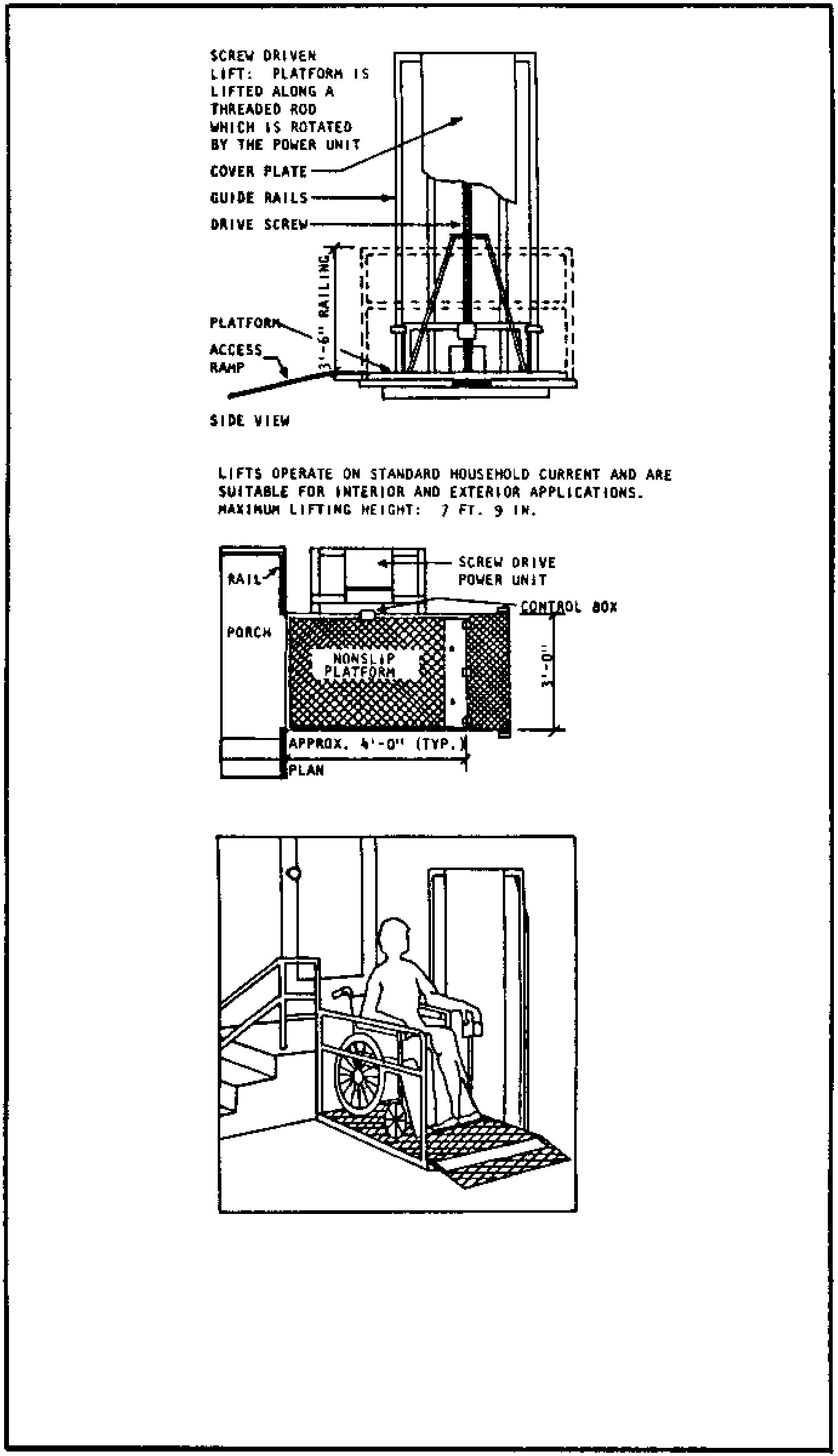

Figure 9
Wheelchair Lift

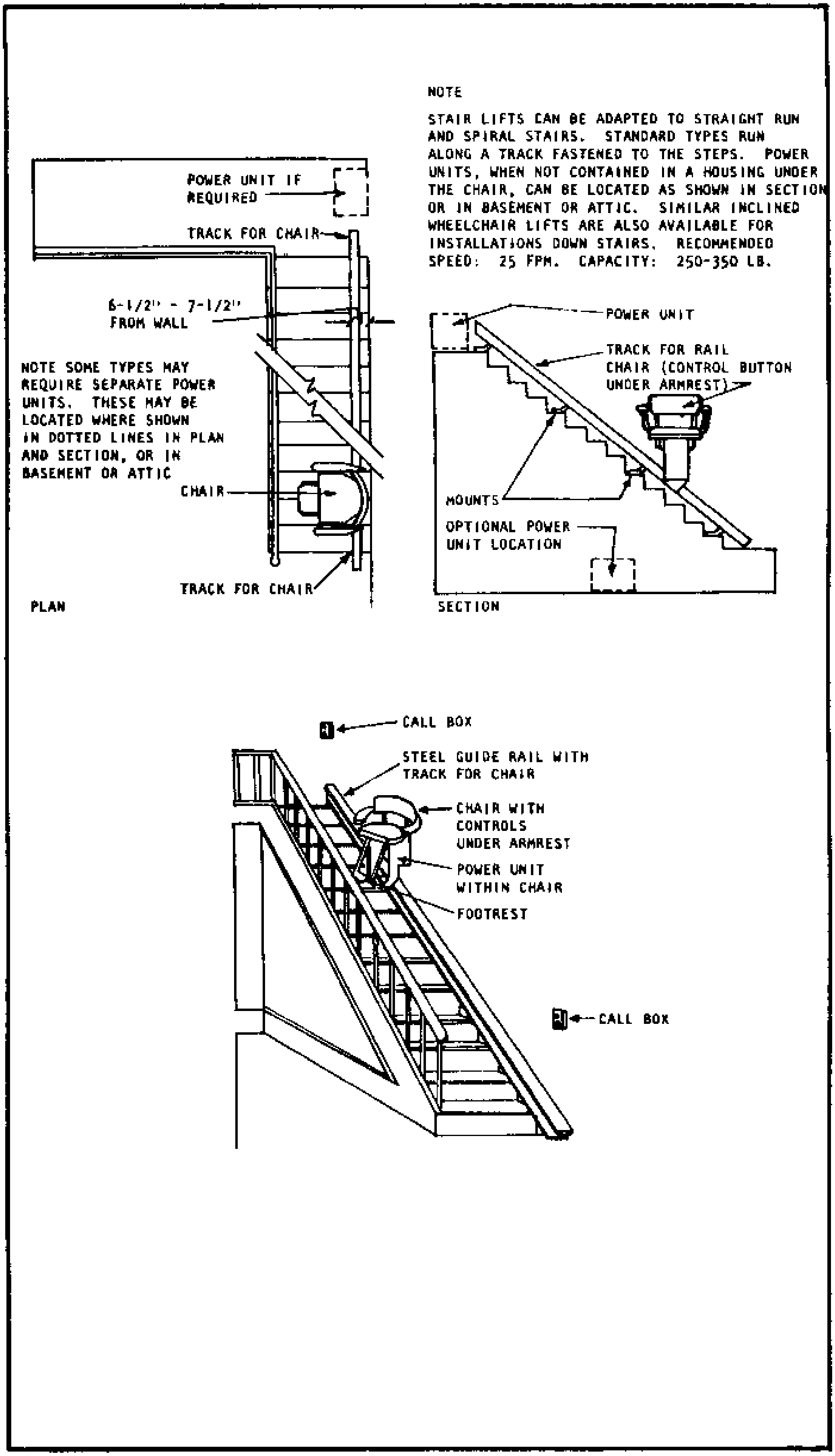

Figure 10
Stair Lift

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1.   AVAILABLE SYSTEMS. Selection of pneumatic tube systems may be made from three types. System shall be single or dual tube type.

a. Conventional Manual System. This system may consist of a single tube or double tube arrangement and is effectively used for a maximum of three stations. When there are more than three stations in a conventional system, each department must communicate directly with one central station. Carriers sent from one location to another must be transferred manually from one tube to another at the central station (see Figure 11).

b. Carrier-Actuated Automatic System. This system consists of dispatching tube lines running into a central transfer point which automatically directs carriers into one or more outbound tube loops containing one or more receiving stations. Special carriers fitted with indicator dials or movable magnets are utilized. Operating personnel select the destination of each carrier by adjusting these indicators or magnets (see Figure 12).

c. Station-Selection Automatic System. Similar in operation to the carrier-actuated system except that the destination selection is made by dials or push buttons at each station. Standard conventional type carriers are used. This system can be controlled by a simple supervisory control center or a computer based system utilizing microprocessor technology with keyboard and CRT data display (see Figure 13).

2.   SYSTEM STATIONS. Determine departments which should be equipped with stations and assign a location to each station.

3.   FACTORS AFFECTING STATION SELECTION. Consider the following factors in selecting pneumatic tube stations.

a. Storage Capacity of Stations. Stations attended or unattended.

b. Appearance. Freestanding or wall enclosed.

c. Noise. Refer to paragraph 13, NOISE CONTROL.

d. Economics. When two stations are in adjacent departments, and when department layout, fire separation requirements, and operations permit, specify one double-sided station to serve both.

4.   CARRIER USAGE. Construction and operation of carriers will affect usage as follows.

a. Construction. The carrier body shall be shatterproof transparent or opaque plastic, or metal construction depending on specific requirements and capable of drop test height of 48 inches without damage. The front end of the carrier body should be equipped with felt, rubber, or other soft material padding to reduce noise on impact. Provide positive locking action type to ensure nonspillage. Specify field replaceable seals.

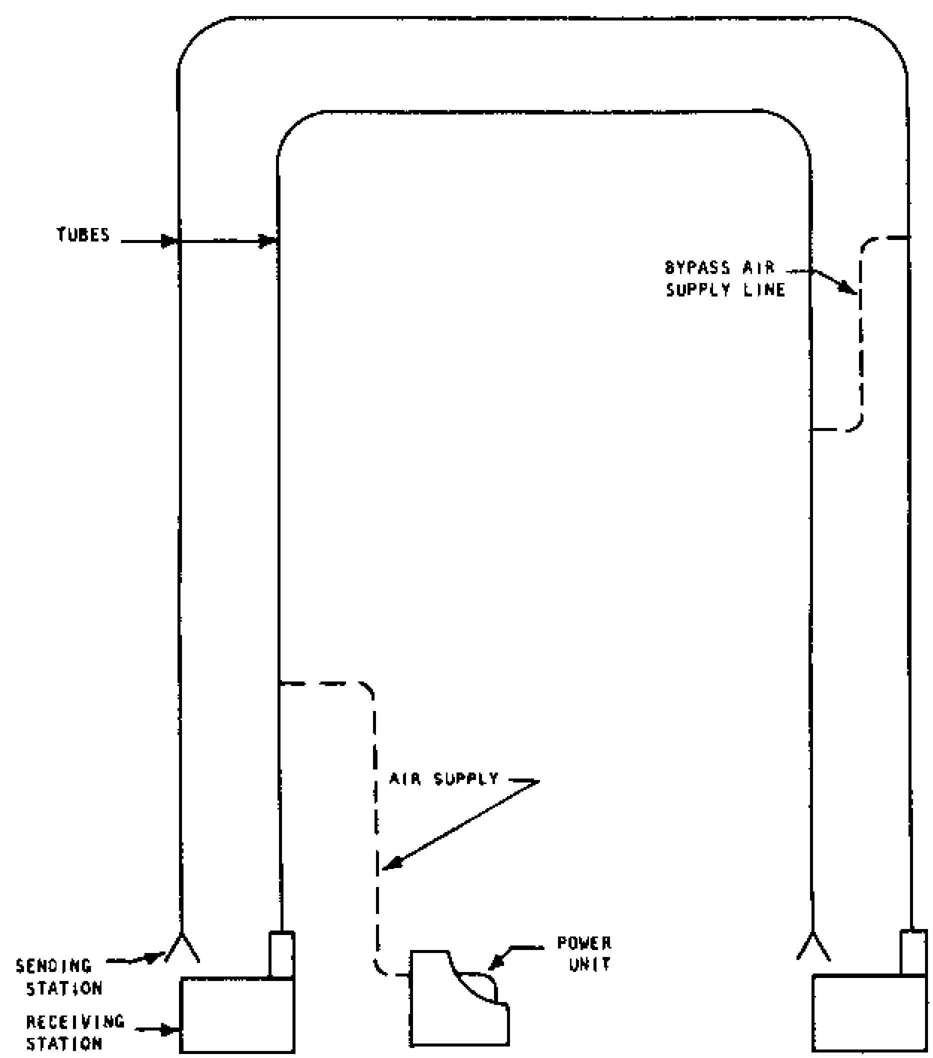

Figure 11
Conventional Manual Pneumatic Tube System

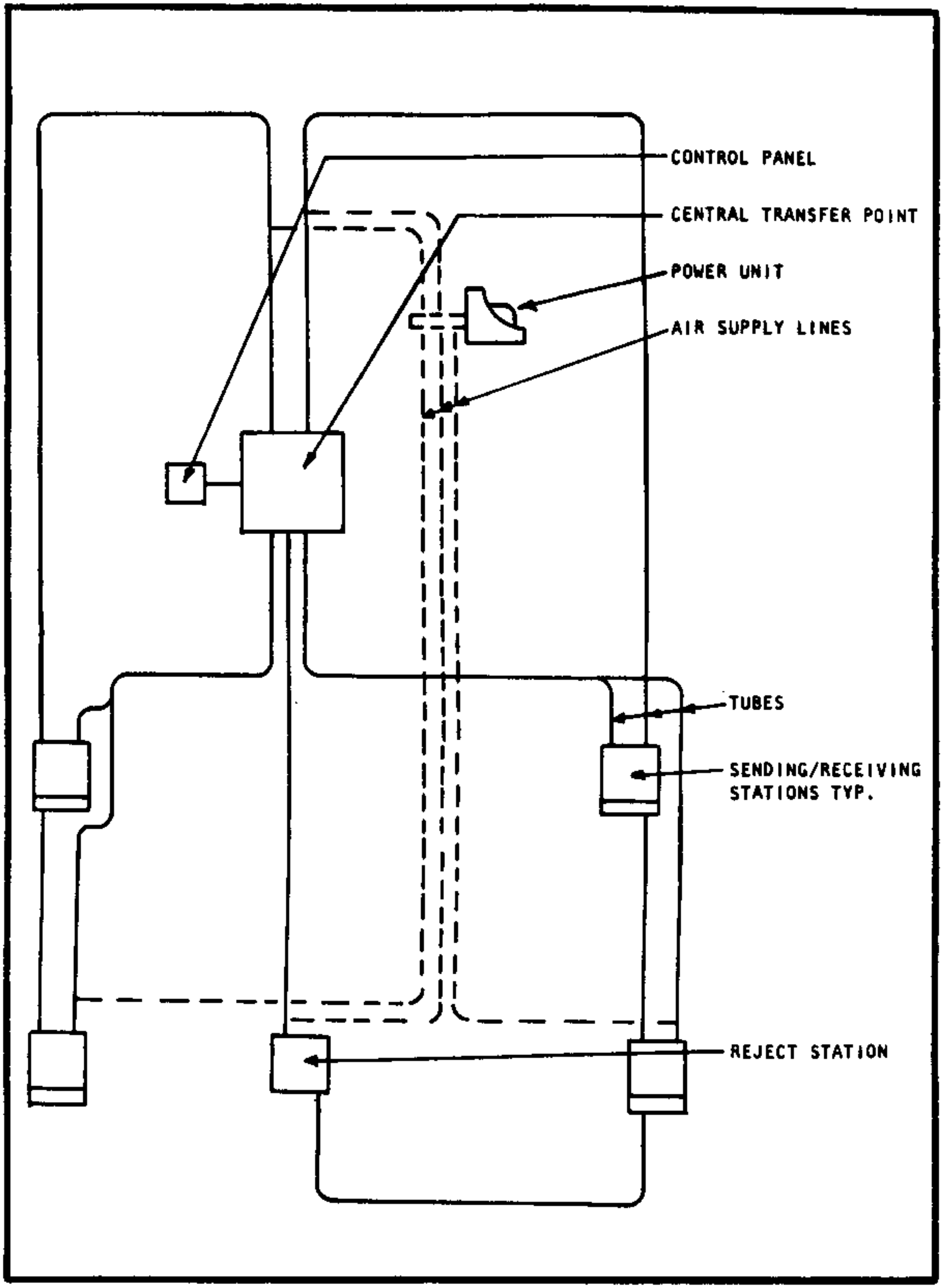

Figure 12
Carrier-Actuated Automated Pneumatic Tube System

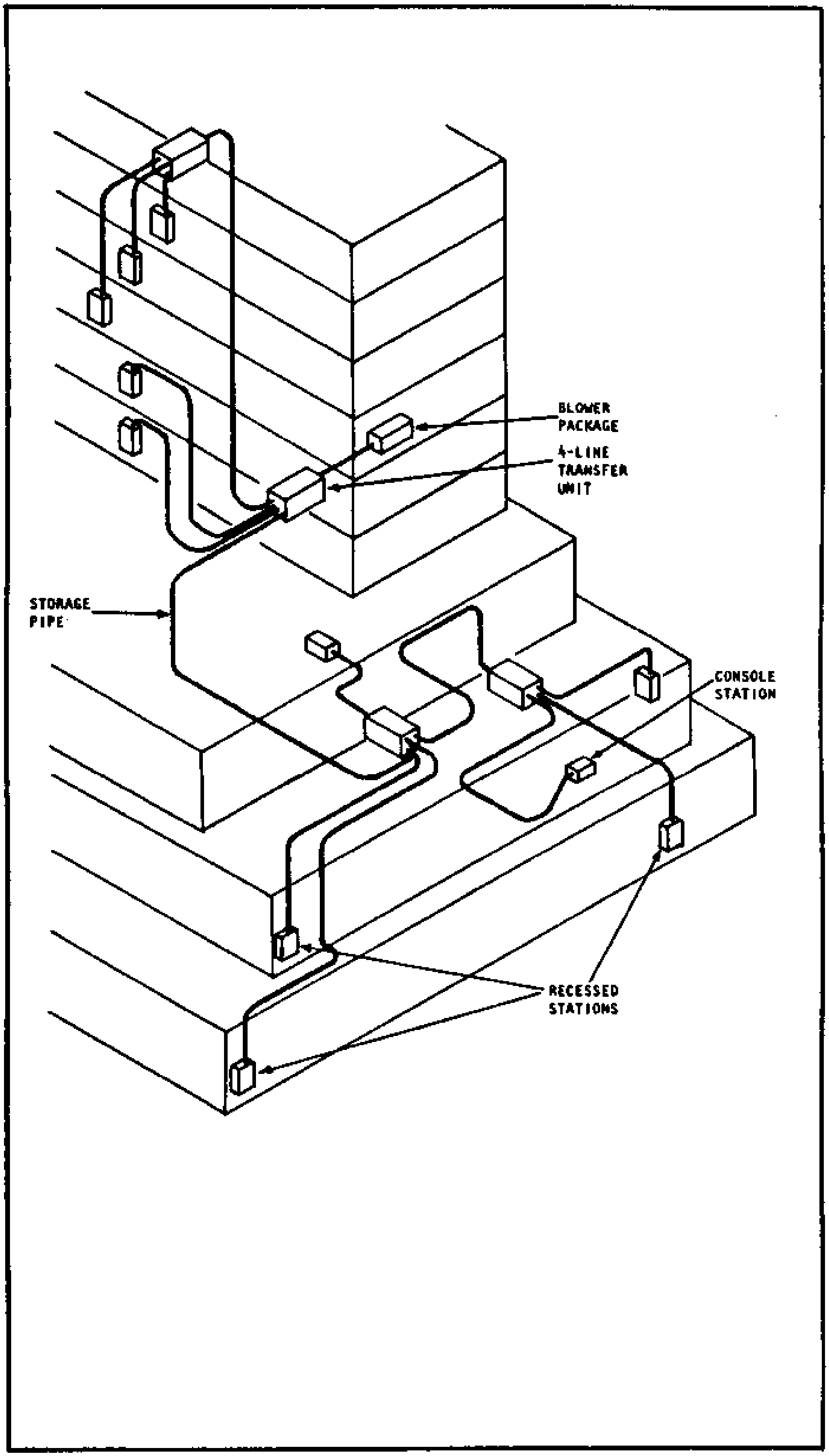

Figure 13
Station-Selection Automatic Pneumatic Tube System

b. Operation. Use standard carriers for conventional manual and station-selection automatic systems, and carriers equipped with indicator dials or movable magnets for carrier-actuated automatic systems.

5. CARRIER SELECTION. Select the size and type of carrier which will conveniently contain and properly handle the material for transmittal. The following sizes refer to the outside diameter or axes of the carrier transmission tubing. The inside clear dimension of the carrier itself is approximately 1 inch less than the size indicated below with clear inside lengths as standard available from 5 inches to 16 inches. Special length carriers are available at extra cost.

a. Conventional Manual Carriers.

2-1/4 inches round
3 inches round
4 inches round
6 inches round
4 inches x 7 inches oval
4 inches x 12 inches rectangular

b. Carrier-Actuated Automatic.

4 inches round
4 inches x 7 inches oval

c. Station-Selection Automatic.

3 inches round
4 inches round
6 inches round
4 inches x 7 inches oval

6. STATION EQUIPMENT. Each station comprises a dispatching unit and a receiving unit. In a single-tube system, the receiving unit and sending unit are one and the same. Use down-delivery receivers where carriers arrive through overhead tubing, and up-delivery receivers where arrival is through tubing from a floor below. Avoid up-delivery receivers where possible to minimize lost carriers. Use dispatching units for upward or downward travel of carriers, depending on individual station requirements.

a. Free Delivery. This station type consists of a chute, basket, or freestanding cabinet with open receptacle for carrier discharge, and exposed tubing. Use free delivery stations where maximum economy is required, and appearance and noise are not of primary importance. Used in twin-tube manual systems.

b. Exposed Cabinet. Use exposed cabinets at locations where neat appearance and fairly quiet operations are desired. With these terminals, carriers discharge into a closed receiver built into freestanding cabinets or set on desks with exposed tubing. Most frequently used with either twin-tube or single-tube systems.

c. Built-In Flush. Use a built-in flush station where neatest possible appearance and quiet operation are desired. Terminal equipment and tubing in this station are concealed in a wall with only the sealed receiving and dispatching doors visible. These doors are flush with the finished walls. Most frequently used in automatic systems but are available in manual systems if required.

7. SYSTEM SELECTION.

a. Factors Affecting Selection. These factors must be considered in selecting pneumatic tube systems.

(1) Size of system.

(2) Number of stations.

(3) Type of station: attended or unattended.

(4) Frequency of transmission.

(5) Flow of work.

(6) Physical layout of system.

(7) Economics involved.

b. Two-Station Systems. Two-station systems will be of the conventional manual type as follows.

(1) Single-Tube, Vacuum/Pressure or Pressure/Pressure Line. In these systems, air flow in the tube can either push a carrier from one station to another under pressure and pull it back under vacuum, or push it under pressure in both directions. Both stations are combination send-and-receive terminals and only one carrier may be sent in one direction at a time. Use this system only for very low traffic flow combined with extremely heavy carriers and where first cost is a factor.

(2) Twin-Tube System. In these systems carriers may be dispatched simultaneously from both stations. For these systems provide:

(a) Conventional manual type carriers with no indicating dials or movable magnets;

(b) A constant operating exhauster when carrier traffic between stations requires more than 20 minutes use in each hour; and

(c) Automatic start-stop controls, when carrier traffic is light.

c. Three to Ten Stations.

(1) Conventional Manual System (Single-Tube). In this system, one common return line is used to send carriers to a central station, when an operator may send selectively to substations, but only to one station at a time. Use this system when low initial cost is important and selective service in one direction is satisfactory, and when infrequent transmission is unobjectionable.

(2) Conventional Manual System (Twin-Tube). This system is a combination of a number of twin-line systems. Conventional manual type carriers are used. Select this system in preference to a single tube when service in two directions is required with high frequency of transmission.

(3) Single-Loop Automatic System. In this system any station may communicate directly with any other station in a system, and only one carrier may be in transit at a time. System may be either carrier-actuated or station-selection automatic type.

d. Over Ten Stations.

(1) Semiautomatic System. The use of more than one semiautomatic system terminating at the central station will allow for multiples of ten stations per line.

(2) Carrier-Actuated Automatic System. Limited to approximately 100 stations. Lower initial cost than station-selection automatic, but the special carrier used in this system is more expensive. This system requires a reject station to recover carriers dialed for nonexisting station.

(3) Station-Selection Automatic System. Use conventional type carriers. A reject station is not required. A malfunction in the system will return carrier to sender or continue to its destination after the malfunction is cleared. This system is the most sophisticated with an unlimited number of stations available. Select this system when the following features are necessary:

(a) Interstation selectivity is required;

(b) Flexibility of system design;

(c) Future expansion of a system;

(d) Around-the-clock usage;

(e) High frequency of transmission;

(f) Heavy flow of work; and

(g) Large number of stations.

8. POWER UNITS. Use blowers or exhausters as motivating forces of a system. Power units used comprise two types: centrifugal and positive displacement. Selection factors are a combination of general factors and special requirements.

a. General Factors. The general factors to be considered include:

(1) Size of system (tube size);

(2) Number of air circuits;

(3) Overall length of longest circuit;

(4) Traffic capacity;

(5) Quietness of operation; and

(6) Future expansion.

b. Special Requirements. When transmission line circuits exceed practical operating lengths, additional auxiliary power units must be installed if appropriate to system design.

9. SAFETY PROTECTION. Pneumatic tubes shall not be run through explosive gaseous areas or other hazardous locations.

10. EXPANSION JOINTS. Install expansion joints where tube runs past building expansion joints or if other.wise needed.

11. HANGERS. Utilize vibration isolation hangers for suspended blowers. Do not use vibration isolation hangers for carrier tubing as this permits tubing to move which may cause joints to leak or fail. Use rigid hangers only.

12. SLEEVES. All sleeves shall be furnished and set in place by pneumatic tube system contractors. Calk spaces between sleeves and tubes tightly to prevent leakage of noise from one space to the other.

13. NOISE CONTROL. Sound power levels of acoustically enclosed blowers have been measured at 63 dB "A" at three feet from blower. This is the noisiest component of a pneumatic tube system. If the occupied area has a noise criteria less than 63 dB "A", the following steps may be taken to reduce the sound power level of the pneumatic tube system below the ambient noise level of the occupied area.

a. Blower. Relocate blower in an area remote from the station where the ambient noise is not objectionable such as in a storage area or a mechanical room. Enclose the blower in an acoustically lined cabinet and line blower ducts with 1-1/2 inches of 1-1/2 pounds per cubic foot density acoustical lining. Provide vibration-isolated blower assemblies.

b. Tubing. Tubing shall be routed away from low noise criteria spaces, such as operating rooms, patient rooms, offices, conference rooms, and classrooms. When tubing must be routed over these rooms or through adjacent walls apply 1-1/2 inch thick, 1-1/2 pound per cubic foot density sound deadening layer of fiberglass insulation. Use tape as described in UL 181, Factory-Made Air Ducts and Connectors, on longitudinal and girth joints. This sound insulation shall extend from the tubing where it is connected at the station and along the path of the tubing to a distance of at least ten feet past the quiet areas or rooms.

c. End Station. Provide a soft carrier landing by installing a check valve above the end station to automatically exhaust excess air pressure and reduce the intermittent noise of the carrier as it lands in the end station. If possible, locate station remote from low noise criteria area.

d. Carriers. Provide carriers with double-end wall to avoid clicking noise of carrier hitting wall of tubing as carrier passes from point to point when traveling in system.

e. Testing. Prior to enclosing walls and ceilings, check all pneumatic tube system tubing, bends, runs, and joints for leaks. Measure noise levels of power units. Ensure check valves at end stations are operating properly.

14. SECURED ACCESS. Provide secured access means to systems which are subject to vandalism. Systems used for pharmaceuticals should be provided with voice and card controls for controlling access to the system.

15. SEISMIC RESTRAINT. See Uniform Building Code, Chapter 23, Seismic Risk Nap Zones III and IV. Use seismic restraints for suspended and floor-mounted power units and for carrier tubing when tubing is more than 12 inches from supporting structure and is suspended from hangers.

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ANSI A117.1-80	Specifications for Making Buildings and Facilities Accessible to, and Usable by, the Physically Handicapped

American Society of Mechanical Engineers, 345 East 47th St, New York, NY 10017.

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NFPA 70-84	National Electrical Code
NFPA 101-81	Code for Safety to Life from Fire in Buildings and Structures

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DM-1 Series	Architecture
DM-2 Series	Structural Engineering
DM-3.05	Compressed Air and Vacuum Systems
DM-3.10	Noise and Vibration Control for Mechanical Equipment

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DM-4.04	Electrical Utilization Systems
DM-33.02	Naval Regional Medical Centers - Design and Construction Criteria
DM 33.03	Medical Clinics and Dental Clinics - Design and Construction Criteria
DM-37.01 (Interim)	Swimming Pools (available from nearest NAVFACENGCOM Field Division)
P-355	Seismic Design for Buildings
MIL-HDBK-1008	Fire Protection for Facilities Engineering, Design, and Construction
MO-322	Inspection of Shore Facilities

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NFGS 14200	Electric (Passenger) (Freight) Elevator
NFGS 14214	Hydraulic (Passenger) (Freight) Elevator

Uniform Building Code, International Conference of Building Officials, 5360 South Workman Mill Rd, Whittier, CA 90601.

Vertical Transportation, 2nd Edition, George R. Strakosch, John Wiley & Sons, Incts., 605 Third Ave, New York, NY 10158, 1983.

Vertical Transportation Standards, National Elevator Industry, Inc. 630 Third Avenue, New York, NY 10017.

Buffer - A device designed to stop a descending car or counterweight beyond its normal limit of travel by storing or by absorbing and dissipating the kinetic energy of the car or counterweight.

Building Code - An ordinance which sets forth requirements for building design and construction, or when such an ordinance has not been enacted, one which follows the Uniform Building Code.

Car, Elevator - The load-carrying unit including its platform car frame, enclosure, and car door or gate.

Car Enclosure - The top and the walls of the car resting on and attached to the car platform.

Car Frame (Sling) - The supporting frame to which the car platform, upper and lower sets of guide shoes, car safety, and the hoisting ropes or hoisting-rope sheaves, or the hydraulic elevator plunger or cylinder are attached.

Car Platform - The structure which forms the floor of the car and which directly supports the load.

Control - The system governing the starting, stopping, direction of motion, acceleration, speed, and retardation of the moving member.

Controller - A device or group of devices which serves to control in a predetermined manner the apparatus to which it is connected.

Designated Attendant - When elevator operation is controlled from inside the car (attendant service, independent, hospital service, and other similar operations), it shall be considered as being operated by a designated attendant.

Designated Level - The main floor or other level that best serves the needs of emergency personnel for fire fighting or rescue purposes.

Door or Gate (Car or Hoistway) - The movable portion(s) of the car or hoistway entrance which close the opening providing access to the car or landing.

Door or Gate Power-Operator - A device or assembly of devices which opens a hoistway door and a car door or gate by power other than by hand, gravity, springs, or the movement of the car; and which closes them by power other than by hand, gravity, or the movement of the car.

Dumbwaiter - A hoisting and lowering mechanism with a car of limited capacity and size which moves and guides in a substantially vertical direction and is used exclusively for carrying material.

Elevator - A hoisting and lowering mechanism, equipped with a car or platform which moves in guide rails and serves two or more landings.

Emergency Stop Switch - A device located in the car Which, when manually operated, causes the electric power to be removed from the driving-machine motor and brake of an electric elevator or from the electrically operated valves and pump motor of a hydraulic elevator.

Entrance, Elevator, Dumbwaiter, or Material Lift - The protective assembly which closes the hoistway enclosure openings normally used for loading and unloading.

Escalator Skirt - The panels located immediately adjacent to the stop or treadway.

Fire Resistance - The property of a material or assembly to withstand fire or give protection from it. As applied to elements of buildings, it is characterized by the ability to confine a fire or to continue to perform a given structural function or both.

Hoistway (Shaft)- An opening through a building or structure for the travel of elevators or dumbwaiters, extending from the pit floor to the roof or floor above.

Hoistway Enclosure - The fixed structure, consisting of vertical walls or partitions, which isolates the hoistway from all other areas or from an adjacent hoistway and in which the hoistway doors and door assemblies are installed.

Machine - The power unit which applies the energy necessary to raise and lower an elevator or dumbwaiter car or to drive an escalator.

Operation - The method of actuating the control.

Pit, Elevator - That portion of a hoistway extending from the sill level of the lowest landing to the floor at the bottom of the hoistway.

Position Indicator - A device that indicates the position of the elevator car in the hoistway. It is called a hall position indicator when placed at a landing or a car position indicator when placed in the car.

Rated Load - The load which the equipment is designed and installed to lift at the rated speed.

Rated Speed - The speed at which the elevator, dumbwaiter, or escalator is designed to operate.

Safety - A mechanical device attached to the car frame or to an auxiliary frame, or to the counterweight frame, to stop and hold the car or counter-weight under one or more of the following conditions: predetermined overspeed, free fall, or if the suspension ropes slacken.

Travel (Rise) - The vertical distance between the bottom terminal landing and the top terminal landing of an elevator, dumbwaiter, or escalator.

Traveling Cable - A cable made up of electric conductors, which provides electrical connection between an elevator or dumbwaiter car and a fixed outlet in the hoistway or machine room.