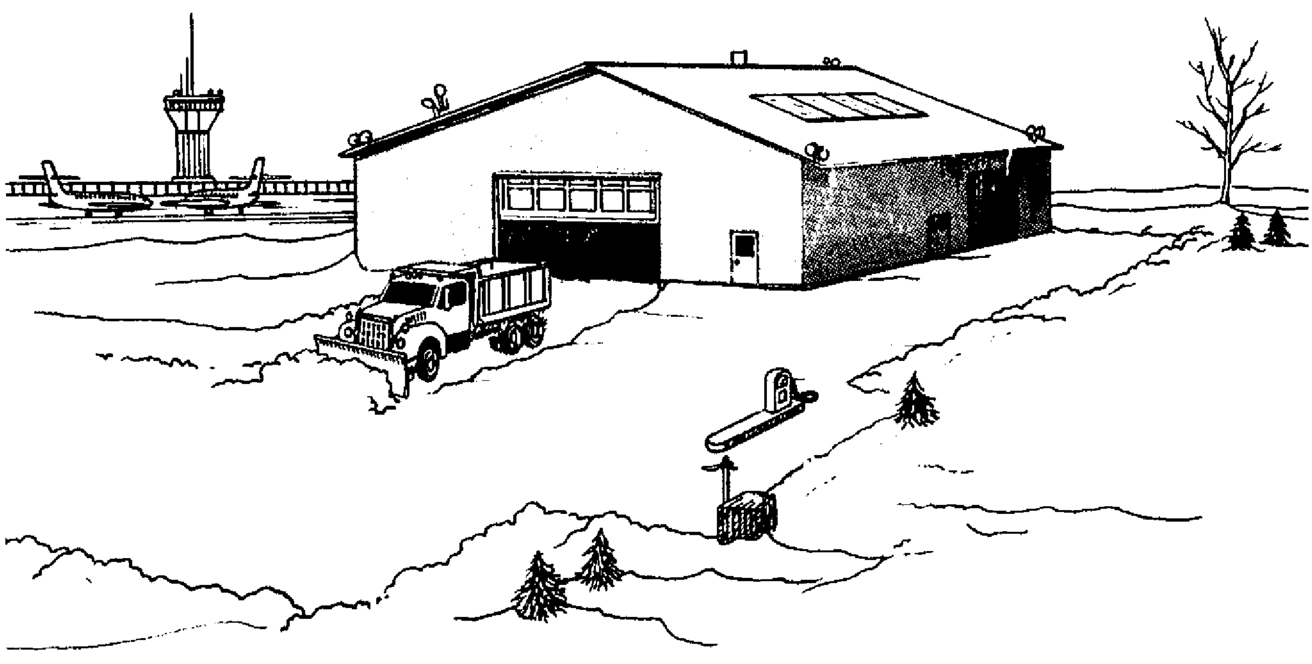
U.S. Department
of Transportation
**Federal Aviation
Administration**

Building for Storage and Maintenance of Airport Snow Removal and Ice Control Equipment: A Guide

Advisory Circular

AC: 150/5220-15
Date: 3/25/83



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Date: 3/25/83
Initiated by: AAS-100

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1. PURPOSE. This advisory circular (AC) provides standards for site selection, design, and construction of buildings for the storage and maintenance of airport snow removal and ice control equipment and materials. It identifies for airport authorities the somewhat unique requirements which need to be considered by their architects and engineers during design of such buildings. In addition, this AC addresses factors which affect the operation of such buildings, i.e., climatic considerations and the physical characteristics peculiar to snow removal equipment and ice control materials.

2. FEDERAL ASSISTANCE. This guide covers design and equipment for a complete service and storage facility. The portions of such a facility eligible for Federal grant participation are limited to those features or facilities spelled out in current grant enabling legislation. If Federal grant assistance is comtemplated, pre-design coordination with an Federal Aviation Administration (FAA) Airports regional or district office is recommended.

3. RELATED READING MATERIAL.

a. AC 150/5200-23, Airport Snow and Ice Control, current edition.

b. Transport Canada document AK-61-87, Sand and Urea Storage Buildings.

c. Transport Canada document AK-76-09-037, Provision of Ground Facilities for Design, Construction, Operation and Maintenance of Airports.

4. OBTAINING CANADIAN DOCUMENTS. Transport Canada documents AK-61-87 and AK-76-09-037 may be obtained from the Airports and Construction Services Directorate, Airport Facilities Branch, Mobile Support and Stationary Equipment Division, Ottawa, Canada KIA-ON8.

Leonard E. Mudd
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Director, Office of Airport Standards

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CHAPTER 1. INTRODUCTION

1. BACKGROUND. Over the last decade, airport authorities have acquired numerous pieces of sophisticated equipment for snow and ice control on the Nation's airports. Adequate storage and maintenance buildings are needed to protect and service this equipment.

a. During the winter months, these buildings provide a warm, sheltered environment to repair and service the snow and ice control equipment. In addition, they protect ice control materials from moisture, contaminants and composition change. During the remainder of the year, these buildings shelter the equipment and materials from adverse environmental conditions and provide a facility where the vehicles can be prepared for future operations.

b. An airport maintenance, storage, and snow removal equipment building designed to the standards of this AC will protect the airport's investment in snow and ice control equipment, as well as in stored ice control materials, and it will support safe all-weather aircraft operations. Airport authorities often find it advantageous to size the building to include storage for field lighting and other airport maintenance equipment, friction measuring equipment, rubber removal devices, and inspection or bird patrol vehicles.

c. These buildings, when adequately sized and centrally located on an airport, offer a center for acting on snow and ice conditions occuring on the airport operational surfaces, monitoring and directing the airport facility maintenance operations, and a convenient location for fueling airport vehicles.

d. Buildings of the complexity required for proper storage and maintenance of the sophisticated snow and ice control equipment on modern airports normally require site specific design. Any sizable building located in an airport environment should be designed by an architectural and engineering firm familiar with airport needs and construction constraints.

2. EXPLANATION OF TERMS.

a. Building. As used in this AC, the word "building" refers to buildings designed and constructed specifically for storage and maintenance of snow and ice control materials and equipment.

b. Vehicle. The word "vehicle" refers to all equipment used by airports to control and remove snow and ice from operational areas. It includes snowplows, snowblowers, sweepers, sanders, spreaders, loaders, carrier vehicles such as trucks used for snow and ice control, and accessory equipment (plows, scrapers, etc.).

3. GENERAL CONSIDERATIONS.

a. Equipment Maintenance. Airports which have a need for snow removal equipment (see AC 150/5200-23, Airport Snow and Ice Control) also have a need for maintenance and storage facilities for that equipment. Diesel-powered equipment, for example, may require either warm storage or engine preheaters to aid in starting. In addition to freezing temperatures and snow, environmental conditions such as rain, wind, heat, dust, sun, and chemical contamination will accelerate equipment deterioration. Except for emergency repair or minor servicing, maintenance should be performed in a warm, sheltered environment, especially during the winter.

b. Materials Storage. The ice control materials and chemicals are subject to deterioration or change of condition, which can make them ineffective or unavailable for use, if they are not stored in a sheltered environment.

c. Personnel. The buildings have to accommodate personnel engaged in snow and ice control equipment maintenance and operation. Appropriate personnel support facilities include office space, lavatories, locker rooms, and training/lunch rooms.

CHAPTER 2. FUNCTIONAL REQUIREMENTS

4. SITE.

a. Convenient Location. Buildings for housing snow removal and ice control equipment should be near the airport's operational areas. Figure 5 suggests, in order of priority, several typical sites. Because of associated activities, including temporary parking, in the vicinity of these buildings, any snow and ice control equipment maintenance building must be located so that such activities cannot inadvertently block any airport fire lane or infringe upon any aircraft operational area. Private or service vehicles should not have to cross runways or taxiways to get to and from the buildings. Buildings must not restrict airport surveillance from either the control tower or the fire station. To avoid the problems inherent in traveling circuitous routes in heavy snow, the buildings should be located to permit vehicles to move directly to and from operational areas.

b. Expansion. The building site should have the capability for expansion to meet an airport's future needs.

c. Regulations.

(1) It is recommended that the buildings be kept below the airport imaginary surfaces defined by Federal Aviation Regulation (FAR) Part 77. When this is not practical, the buildings may penetrate the airport imaginary surfaces where an FAA aeronautical study has determined that the specific location and penetration will not constitute a hazard to air navigation. Most buildings proposed on an airport will require advance notice be given to the FAA.

(2) The building and associated support areas or facilities need to be shown on an approved Airport Layout Plan (ALP). The construction of a maintenance and storage building is normally excluded from environmental impact analysis in accordance with FAA Order 1050.1C, Policies and Procedures for Considering Environmental Impact. Order 1050.1C may be obtained on request from the Department of Transportation, Publications Section, M-442.32, Washington, D.C. 20590.

d. Drainage. A separate drainage system should be provided to collect, separate or treat urea, salt, petroleum, and industrial waste which may be picked up by surface runoff. Guidance on handling potential surface water contamination may be found in AC 150/5320-10, Environmental Enhancement at Airports, Industrial Waste Treatment, current edition.

5. ORIENTATION.

a. Buildings. In those instances where orientation options are available, the building's face containing the large vehicle entrance doors should be parallel to the prevailing winter winds to allow the wind to sweep snow or other windcarried matter away from those doors. Where the orientation options are not available, fences, other buildings or vegetation can be incorporated into the site design to influence winter winds to sweep vehicle entrance doors and ramps.

b. Fueling Facilities. Fueling facilities for diesel fuel, regular and low-lead gasoline should be located on the leeward side of the building. Provision should be made for dealing with fuel spills (see paragraph 4d). Methods for maintaining ice-free fueling areas are suggested in appendix 3.

6. EXTERIOR APPEARANCE AND LANDSCAPING. The exterior finish, landscaping, and overall appearance of the building should blend in with rest of the airport. This is especially important when the building will be near the terminal complex.

a. The building's exterior finish will be a factor in selecting its site. Metal buildings which use long-life exterior cladding merit serious consideration. Metal cladding, however, should not be used in areas where it would interfere with electronic navigational aids or be subject to damage by vandalism or vehicular traffic. The exterior finish materials should be durable and require minimal maintenance.

b. The landscape design may include fences, berms, or a wide variety of vegetation. However, trees, shrubs, and fences which will impede vehicle movement, disrupt visual clearance, obstruct the airport's operational airspace, or be difficult to maintain should be avoided. Plantings and building exteriors should also avoid creating bird habitats which could endanger aircraft operations.

c. Consultation with a landscape architect and other design professionals as well as a meeting with all interested parties during the early planning stages, normally results in an environmentally-compatible and economic building which is located and finished to meet the special requirements of the airport.

CHAPTER 3. CONFIGURATION AND CONSTRUCTION REQUIREMENTS

7. GENERAL. The building should meet the functional requirements of the airport, accommodate local conditions, and be economical in terms of life-cycle costs.

a. Cost. Design costs, initial construction costs, and projected expansion costs should be estimated for the life-cycle cost of the facility.

b. Fire Protection. In most cases, the building will house mechanical equipment which uses flammable fuels. Buildings should, therefore, be as fire resistant as possible. Special consideration should also be given to fireproofing offices and other areas which are located above the ground floor and will be occupied by airport personnel. The walls of the vehicle storage room should have at least a two-hour fire resistance rating, and fire resistant doors should guard openings between vehicle rooms and shop areas. The higher insurance premiums associated with certain flammable construction materials will offset their low initial costs; thus, the life-cycle cost should include insurance.

c. Large Airports. Airports which have more than two million square feet (99 000 m^2) of runway and associated taxiway and ramp area to clear during winter operations may require up to 50 percent more square feet of building floor area than suggested below.

8. CONFIGURATION. The size, variety and total number of snow and ice control vehicles required by the airport determines the dimensions of the building. The building's primary functions are to store and service snow removal and ice control equipment and materials. The layout should expedite snow removal and ice control. Maintenance support arrangements with other private or municipal organizations may reduce the need for on-airport maintenance and associated maintenance facilities. Standard configurations for snow and ice control equipment storage buildings are:

a. Overall Design.

(1) Central Aisle Construction. An efficient design for larger buildings (see figure 3) is a central drive-through aisle, with back-in vehicle stalls. While providing central access to vehicle parking spaces, this design requires few doors; usually one large door on each end of the building for vehicle entrance and exit, and one or more smaller access doors in the maintenance area for personnel. This type of design adapts well to modular-type additions.

(2) Drive Through Construction. A drive-through stall-type building (see figure 4) is suitable in many locations. The drive-through feature provides parking for rows of vehicles with up to three vehicles in each row. Each row requires a separate entrance and exit door. For a very large building, the number of doors thus needed will outweigh the lesser overall floor space requirement, which is the advantage of the drive-through over the central-aisle design.

(3) Back-In Construction. Smaller buildings may need only a simple back-in stall design.

(4) Modified Design. A modified design may incorporate features of two or all three of the above layouts.

b. Specific Features.

(1) Aisles, Doors and Service Bays. The width of the largest piece of equipment the airport expects to acquire will determine the minimum width for aisles and doors as well as parking and service bays.

(2) Sand, Urea, and Salt Storage. The best storage for these materials is inside the building. Sand, urea and salt storage areas need adequate space for loading the spreader trucks. While it is desirable to have enough space to permit inside loading, as a minimum the building design should provide for loading the materials through exterior doors. Designers should allocate space for storing and loading sand, urea, and salt in accordance with the guidelines presented in paragraph 10.

(3) General Storage. Areas will be required for storage of oil, grease, tires, antifreeze, hand tools, etc. To reduce the space needed for storage, some items which are used less frequently may be stored in the roof trusses or over the ceilings.

(4) Machine Room. Sufficient space should be alloted for major power tools required to service equipment stored in the building. This room may also contain a limited parts storage facility, the mechanical equipment for heating/ventilating/cooling the building, and the compressed air and hydraulic equipment needed to support the maintenance operation. Since most fire and safety codes do not permit storage of combustible materials in an equipment room, combustible parts or packaging will need a separate storage area.

(5) Combined Facilities. To reduce construction and operating costs of airport support facilities, it is often possible to combine snow and ice control equipment storage with fire and rescue facilities, or with office and administrative personnel facilities.

9. SNOW AND ICE CONTROL EQUIPMENT STORAGE AREAS. The following methodology provides the FAA guidance for floor area or space requirements for equipment storage:

a. Snowblowers. From figure 1, determine the number of parking spaces needed for snowblowers based upon the area of pavement to be cleared and the annual aircraft operations at the airport.

b. Plows. From figure 1, determine the number of parking spaces needed for snowplows based on the number of snowblowers identified and the type of airport.

c. Spreaders and Sweepers. Figure 2 reflects the need for one parking space for a dry materials spreader and one parking space for an airport runway sweeper for each 750,000 square feet (74 925 m^2) of pavement area to be cleared. Add the parking spaces for spreaders and sweepers to the parking spaces determined in figure 1 for the total number of parking spaces required.

d. Floor Area Requirement. Parking spaces are 25 feet by 40 feet (7.5 x 12 m) except for parking spaces for spreaders without plows, snowblowers with capacities under 2000 tons/hr, and smaller runway sweepers. Spreaders without plows and small snowblowers can normally be parked in a space 20 feet by 30 feet (6 x 9 m). The smaller runway sweepers can normally be parked in a space 20 feet by 40 feet (6 x 12 m). Appendix 2 provides dimensions for parking spaces for other pieces of support equipment.

10. ICE CONTROL MATERIALS STORAGE AREAS.

a. Storage Methods.

(1) Sand and Urea. Sand and urea should be stored separately and kept dry. Masonry walls should be used for bulk storage rooms. Handling and storing urea shipped in bags is more labor intensive but less demanding in terms of the storage facility requirements.

(2) Liquid De-icing Fluid. Bulk storage of liquid de-icer should be in outside tanks. Inside storage may be considered for small quantities of de-icer in drums.

(3) Salt. Salt storage may be in bulk or in bags. Salt for entrance roadway or sidewalk ice control applications, however, must remain segregated from materials to be used on the aeronautical operational areas. Salt storage areas should be designed to discourage personnel from using salt in any location or manner which could result in salt coming in contact with aircraft.

b. Storage Location. Sand and urea storage areas should be on the leeward side of the building, based upon prevailing winter winds, for economy in maintaining the ice control materials in a friable condition. Outside tanks for liquid de-icer fluid should be buried to prevent the chemicals from slushing and to provide clear ramp areas

c. Space Needs. Space requirements for storage of snow and ice control materials depend on the quantity of friable sand, urea and liquid de-icer required for the winter. Typical snow and ice control material storage areas are:

	Range in Square Feet	Range in Square Meters
Sand Storage	100-400	9.3-37.2
Urea (Bagged or Bulk) Storage	100-400	9.3-37.2
Salt Storage	100-300	9.3-27.9
Lubrication, Oil, and Grease Storage	100-150	9.3-13.9

11. SUPPORT AREAS.

a. Administrative and Maintenance Support Areas. Typical support areas are:

	Range in Square Feet	Range in Square Meters
Supervisor's Office	100-150	9.3-13.9
Mechanics' Office	100-150	9.3-13.9
Locker Room	50-200	4.6-18.6
Emergency First Aid Room	50-300	4.6-27.9
Lunch/Training Room	100-300	9.3-27.9
Lavatory	100-150	9.3-13.9
Parts Storage Area	100-150	9.3-13.9
Welding Area	100-200	9.3-18.6
Bench Area (along walls)	100-200	9.3-18.6
Tire Change and Tire Chain Installation Area	50-100	4.6-9.3
Repair Bay (30 to 40 feet by 20 to 25 feet)	600-1000	55.7-92.9
Steam Cleaning Bay (30 to 40 feet by 20 to 25 feet)	600-1000	55.7-92.9

b. Special Equipment Areas. Typical areas for special equipment are:

	Range in Square Feet	Range in Square Meters
Major Power Tools	50-100	4.6-9.3
Heating, Ventilating and Air Handling Equipment	100-400	9.3-37.2
Hydraulic Lift, Vacuum Pump, and Air Compressor	50-100	4.6-9.3
Steam Generator	100-150	9.3-13.9
Emergency Power Generator	100-300	9.3-27.9
Galley or Kitchen	100-420	9.3-39.2

12. CONSTRUCTION REQUIREMENTS.

a. Local, State, and National Codes. Applicable codes must be followed for fire protection and unique structural requirements, such as earthquake or tornado resistance, and utility connections.

b. Floors. The building should have a concrete floor slab. Sufficient bearing capacity must be designed into the floor slab to support both concentrated and uniform loads from the snow and ice control equipment and materials. Normally, wire mesh or reinforcing steel should be placed in the floor slab.

c. Drainage. Melting snow and ice from the equipment stored or serviced in the building will require drainage facilities. The floor should be sloped to an adequate number of floor drains to prevent puddling on interior floor surfaces. Threshold drains will be needed as well, both to handle the drainage from melting snow and to aid in the routine cleaning of the building.

d. Ceiling Height or Vertical Clearance. Vertical clearance between the floor and the ceiling of the building should be 22 feet (6.7 m). This clearance accommodates large snowplows with high vertical support structures as well as large sweepers with high blower ducts, and it will allow material spreader trucks to elevate their beds for maintenance.

e. Doors. Vehicle entrance doors should be overhead industrial type, either of roller or counterweight design. And they should be heavy duty and easily repairable in the event of minor accidents.

(1) Clearance. Airport sweepers, snowplows, and snowblowers are normally much wider than highway type vehicles, and they often have bulky projections not visible from the operator's position. These projections can cause clearance problems as the equipment passes through most doors or other limited width openings. For this reason, it is recommended that, if possible, extra clearance be provided in door sizes. Minimum door size requirements are:

(a) Large Equipment. Large plows, blowers, and sweepers require doors 18 feet high by 25 feet wide (5.5 m x 7.6 m).

(b) Medium and Intermediate Equipment. Medium size snow removal equipment will require doors 18 feet high by 20 feet wide (5.5 m x 6.1 m).

(c) Small Equipment. For small equipment, doors 16 feet high by 18 feet wide (4.9 m x 5.5 m) are adequate.

(2) Weatherproofing. All overhead doors and exits should be weatherstripped to prevent the infiltration of air, moisture, and snow.

(3) Thresholds. A robust steel plate with checkered design on the top surface should reach from jamb to jamb in the door opening. In areas having an extremely cold climate, heated door thresholds, with integral drains, may also be necessary to prevent ice or frozen doors. Alternate heating systems for thresholds may be found in appendix 3.

(4) Door Operators. Electric door operators should be installed on overhead doors which are used on a regular basis. Their design should include an overide manual operation. Pneumatically operated devices for either activating the electronic door operator or alerting personnel inside the building to open the door are discouraged because of the inherent freezing problems. Mechanical-electrical safety devices should be incorporated into overhead doors so that, if the bottom edge of a door touches a person or machine, the door will automatically reopen.

(5) Bollards or Guardrails. Door frame protection devices should be installed on all doorways through which vehicles will pass.

(6) Control. At least one glass panel should be provided at the door operator's eye level in each door through which the equipment will be passing.

f. Roof.

(1) Loading. Roofs should not only be designed to withstand snow and wind loads, but should also have the structural capacity to accommodate loads hung from or stored on roof trusses.

(2) Drainage. Runoff from the roof should be carried into a storm sewer system if at all possible. Water must not be allowed to drip onto the thresholds or in front of door openings where it can turn to ice.

g. Insulation. In most areas of the United States, insulation of the roof and walls is cost-effective.

13. MECHANICAL.

a. Heat. Airport operators should equip the building with heating units with the capability of maintaining 40°F (4°C) ambient air temperature in the vehicle storage area of the building. Maintenance and office areas should be capable of being heated to 60°F (18°C). If heat is not provided for the area where sand is to be stored, the sand must be in a dry, friable state when stored. Airport operators may choose to provide radiant overhead heat and/or heated floors in the sand storage area to ensure that the sand is dry and friable when needed for ice control. For alternative heating methods see appendix 3.

b. Ventilation. Interior areas of the building which are subject to vapor accumulation should be ventilated to preclude the buildup of fumes that might be harmful to personnel, or vapors which would damage mechanical equipment, corrode roof deck, or saturate the insulation.

c. Air Compressor. When provided, the air compressor and tank system should deliver air at a minimum of 100 psi and provide a minimum of 60 cubic feet (1.7 m^3) of tank storage. Multiple quick disconnect outlets should be provided in the shop, tire change area, and other areas where compressed air may be used.

d. Engine Exhaust Discharge. Ducts should be provided to discharge engine exhaust from vehicle service areas.

e. Fire Hydrants. At least one fire hydrant should be provided at each end of the building.

f. Fire Protection. Fire protection should be provided in battery, work bench, and solvent storage areas. This protection can be provided by portable fire extinguishers, or by water or foam sprinkler systems.

g. Floor Drains. All floor drains should have slotted cast steel covers.

14. LIGHTING AND ELECTRICAL.

a. Service Panel. Electrical service panels should be installed in an accessible location.

b. Lights. Lights should be manually controlled and of industrial high bay, self-cleaning type for dusty atmospheres. The following table may be used to estimate the electrical load for fluorescent lighting of areas in maintenance buildings.

Area/Function	Power
Equipment Storage	1 watt per square foot (1 watt/.09 m^2)
Repair bays	5 watts per square foot (5 watts/.09 m^2)
Offices/locker facilities, etc.	5 watts per square foot (5 watts/.09 m^2)

Exterior lighting in areas adjacent to door entrances should be provided to illuminate vehicle movements during low visibility conditions.

c. Outlets. All storage and maintenance bay areas should have 110/220 volt electrical outlets. Planned workbench areas should have outlets at bench level.

15. INTERIOR FINISHES.

a. Interior Walls. In a free-standing building, the interior walls may be constructed of masonry or wood or metal framing covered with sheet rock, metal sheeting, or comparable non-combustible surface. A reinforced, parged, and moisture proofed concrete retaining wall should separate any sand/urea/salt storage area from the rest of the building. All masonry walls should be painted on the interior surfaces to assist in illumination and moisture control.

b. Floors. Concrete sealer should be applied to all concrete floors. Floors should be painted only where floor area demarcation is necessary, i.e., walkways, safety zones, areas with restricted clearance, etc.

c. Roof. Steel joists and the underside of roof decks should be painted with a suitable finish to protect against the corrosive condensation produced by the drying of wet sand or snow/ice control equipment in an enclosed area.

16. SOUND CONTROL. The building should be designed to reduce the noise level to below 60 Ldn day-night sound level in work areas. This is particularly important at airports which serve multi-engine, turbine-powered aircraft.

PLOW PARKING SPACE SELECTOR

1. DETERMINATION OF THE NUMBER OF SNOWBLOWER SPACES MUST BE COMPLETED PRIOR TO DETERMINING PLOW PARKING SPACES.

2. DETERMINE PLOW REQUIREMENTS AS FOLLOWS:

   a. COMMERCIAL SERVICE AIRPORTS: FOR EACH REQUIRED HIGHSPEED BLOWER PARKING SPACE, TWO PLOW SPACES ARE NEEDED.

   b. GENERAL AVIATION/RELIEVER AIRPORTS: FOR EACH REQUIRED HIGHSPEED BLOWER SPACE PROVIDE ONE PLOW SPACE.

NOTE: ALL EQUIPMENT STALLS SHOULD CORRESPOND IN CAPACITY; THAT IS, A LARGE BLOWER SHOULD BE ACCOMPANIED BY A LARGE PLOW.

SNOWBLOWER & SNOWPLOW SPACE SELECTOR

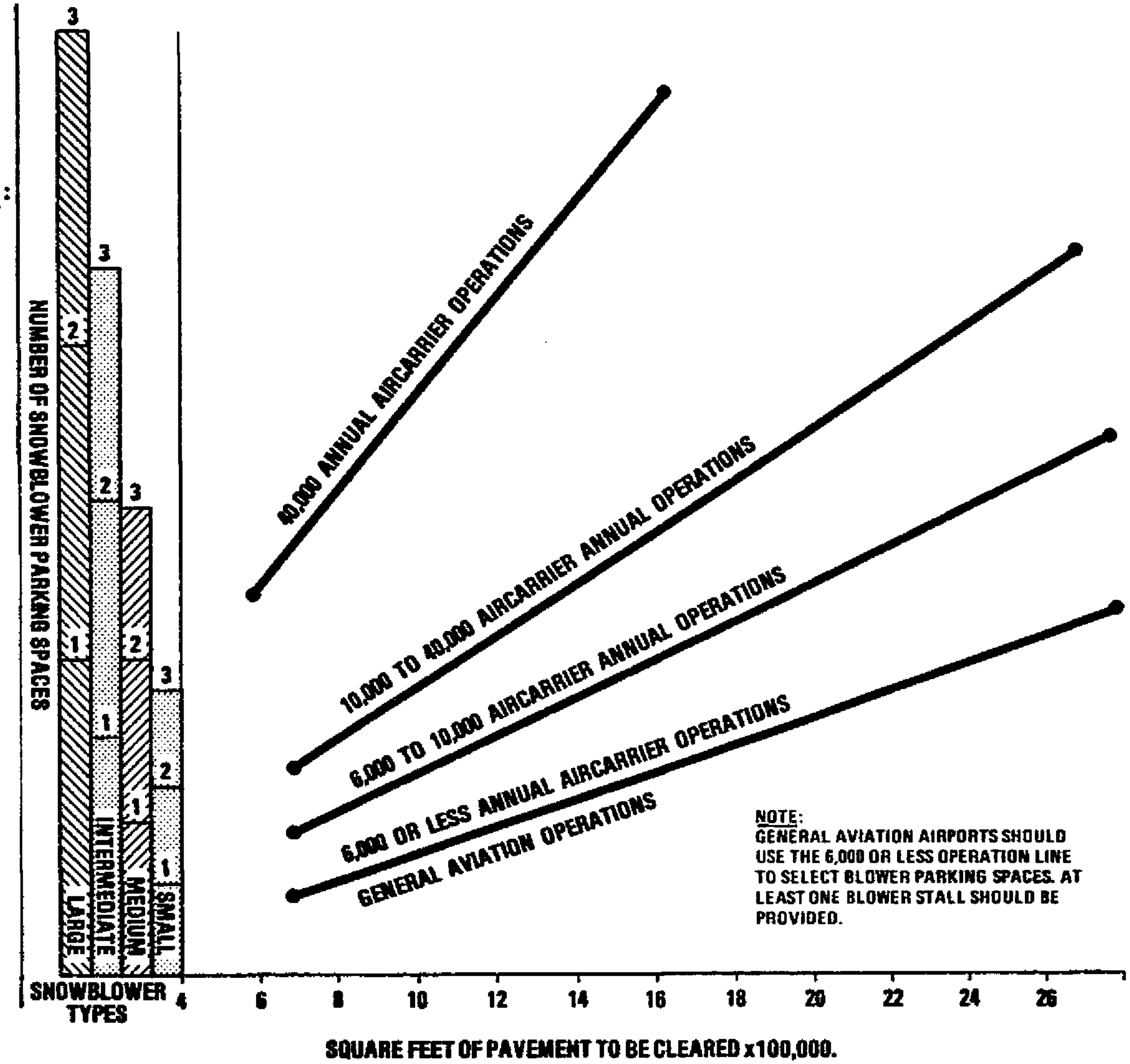


Figure 1. Snowblower and snowplow space selector

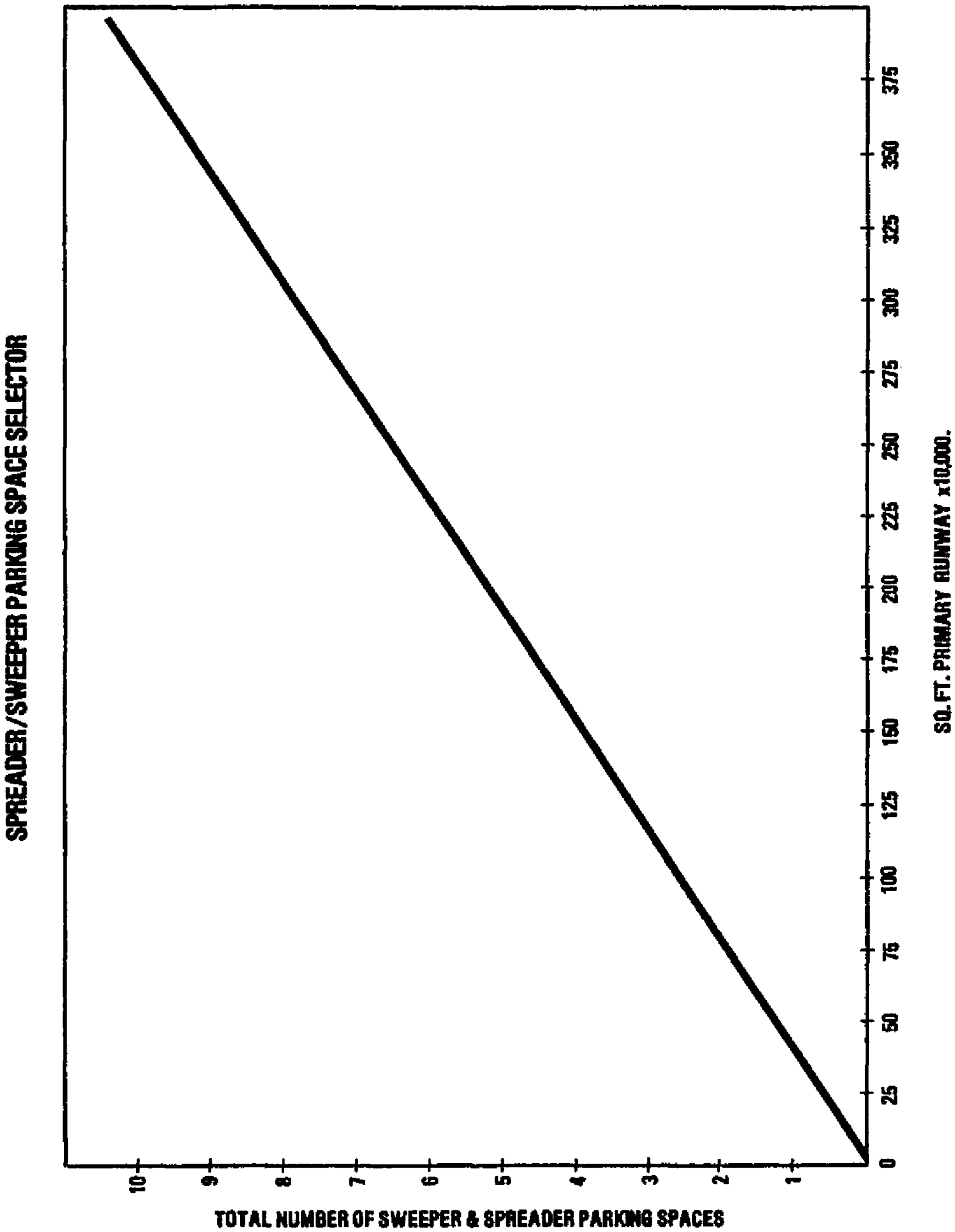


Figure 2. Spreader and sweeper space selector.

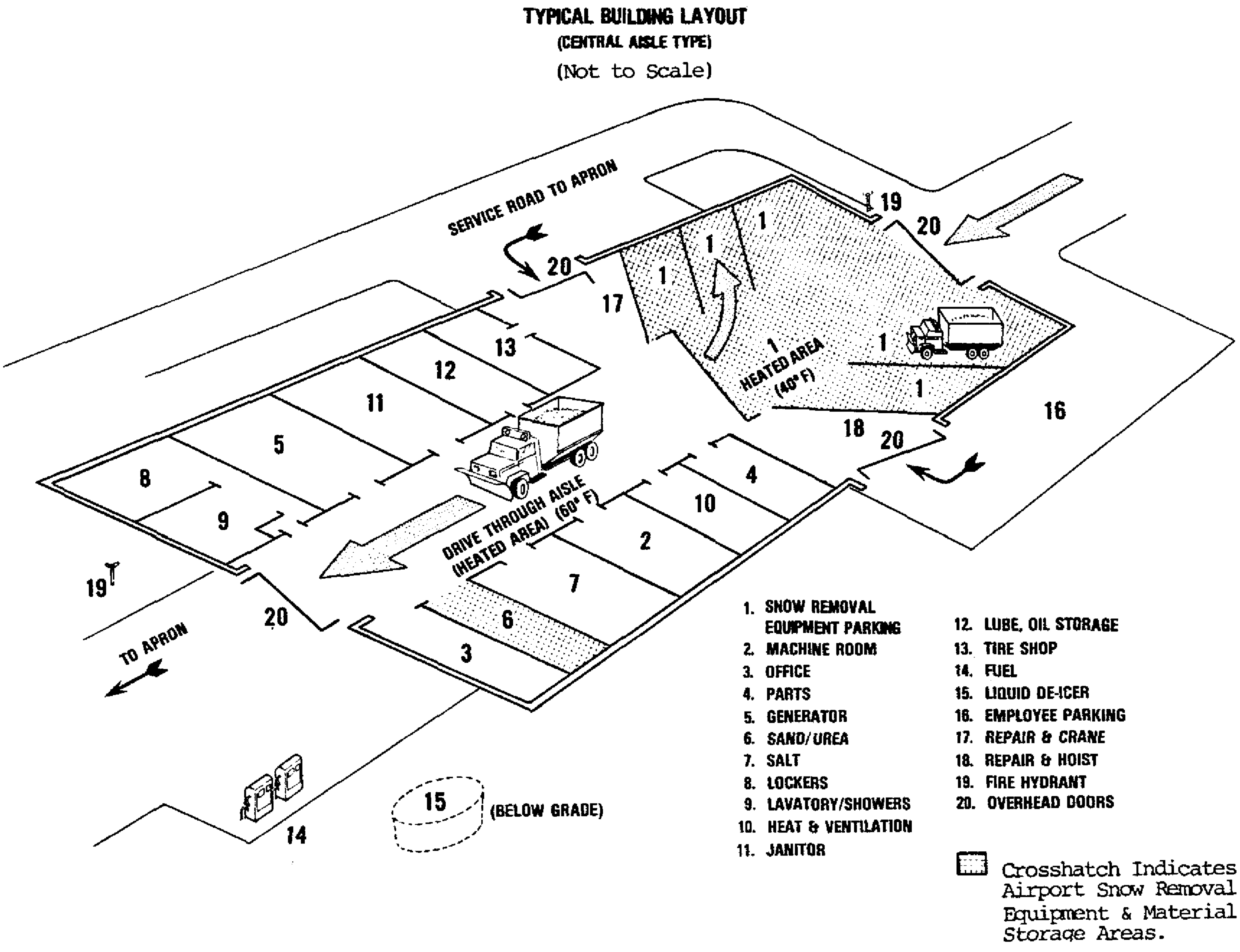
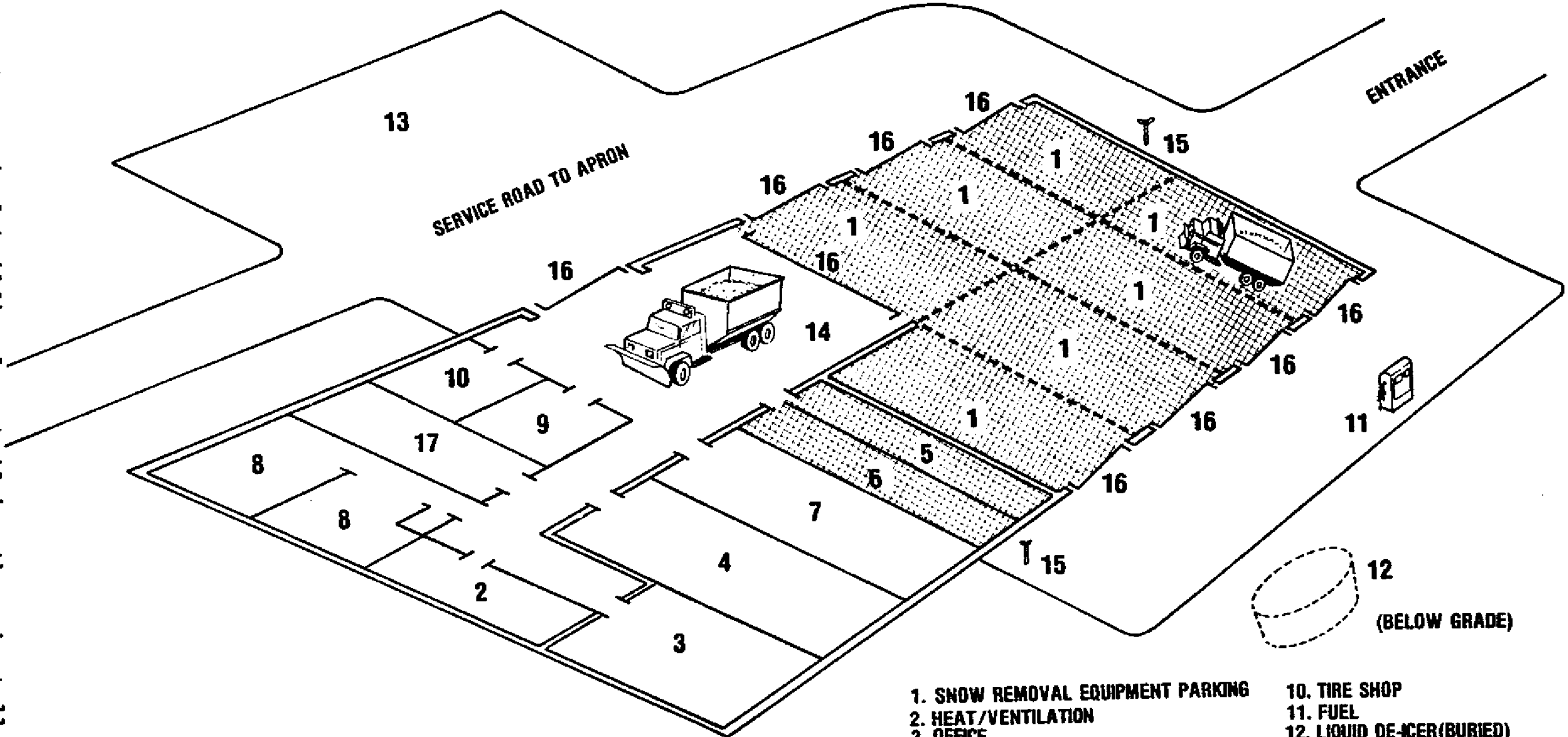


Figure 3. Typical building layout (central aisle type).

TYPICAL BUILDING LAYOUT
(Drive Through Stall Type)



CROSSHATCH INDICATES AIRPORT SNOWREMOVAL EQUIPMENT & MATERIAL STORAGE AREAS.

1. SNOW REMOVAL EQUIPMENT PARKING
2. HEAT/VENTILATION
3. OFFICE
4. PARTS
5. SAND
6. UREA
7. SALT
8. LAVATORY/LOCKERS
9. LUBE, OIL STORAGE
10. TIRE SHOP
11. FUEL
12. LIQUID DE-ICER(BURIED)
13. EMPLOYEE PARKING
14. REPAIR/CRANE/HOIST
15. FIRE HYDRANT
16. OVERHEAD DOORS
17. STORAGE

Figure 4. Typical building layout (drive through stall type).

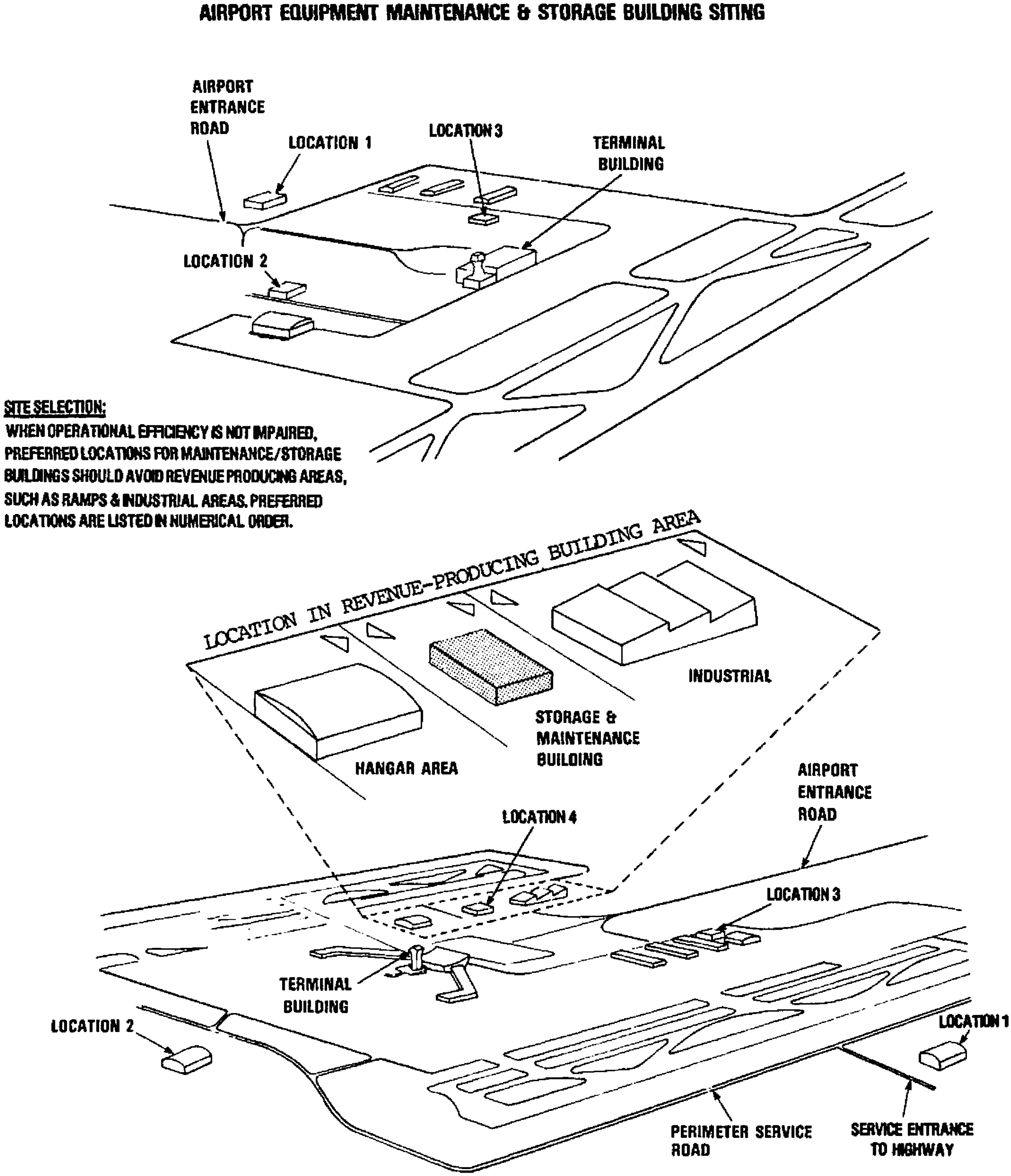


Figure 5. Airport equipment, maintenance, and storage building siting

APPENDIX 1. EXAMPLE OF BUILDING SIZE COMPUTATION

This appendix provides sample calculations of the size of an airport snow and ice control equipment storage and maintenance building. A hypothetical airport, VIP International, is used to illustrate how to make these calculations.

1. OPERATIONAL AREAS. The amount of operational area to be kept open during periods of snowfall must be calculated. (See AC 150/5200-23.) In this example. VIP International airport has over 40,000 annual air carrier operations and 1,600,000 square feet (14 864 m^2) of pavement that must be cleared.

2. CLEARANCE TIME. Using AC 150/5200-23, determine the recommended time for snow clearing operations. Since airports with 40,000 or more annual scheduled air carrier operations should be able to remove one inch (2.54 cm) of snow within 30 minutes, VIP International should be able to clear the operational area in 30 minutes.

3. PARKING SPACES.

a. Snowblowers. Using figure 1, and the area of pavement to be cleared, determine the number of parking spaces needed for snowblowers. VIP International needs parking spaces for three large snowblowers.

Author's Note: Variables such as equipment efficiency, snow density, etc. have been taken into account in figure 1.

b. Snowplows. Using figure 1, it is calculated that VIP International will need sheltered storage for six large plows.

c. Spreaders and Sweepers. From figure 2, determine the number of parking spaces needed for spreaders and sweepers. VIP International needs four additional parking spaces to accommodate two dry material spreaders and two airport sweepers.

4. BUILDING FLOOR AREA. Using the standard parking space dimensions in paragraph 9d., the recommended floor area for a snow and ice removal equipment maintenance building at VIP International would be:

	SQUARE FEET	SQUARE METERS
Three large blowers 25 feet by 40 feet (7.5 x 12m) each.	3,000	270
Six large plows 25 feet by 40 feet (7.5 x 12 m) each.	6,000	540

	SQUARE FEET	SQUARE METERS
Two spreaders 20 feet by 30 feet (6 x 9m) each.	1,200	110
Two sweepers 20 feet by 40 feet (6 x 12m) each.	1,600	144
One wheel loader 20 feet by 40 feet (6 x 12m)	800	72

The ancillary support area is calculated using floor area recommendations in paragraph 11. The following dimensions are considered typical for a medium-size commercial airport:

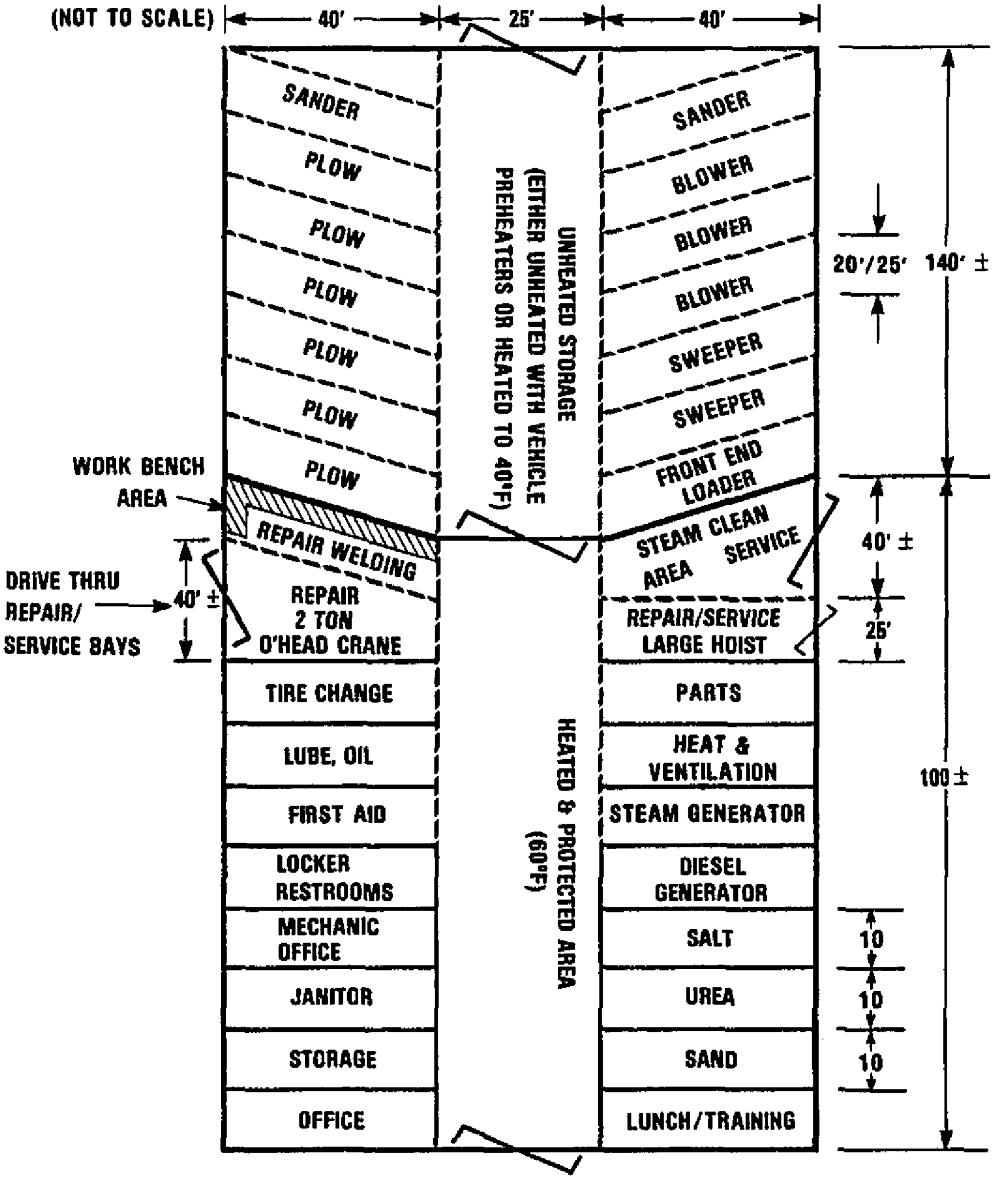
	SQUARE FEET	SQUARE METERS
One combined lavatory and locker room	350	33
One lunch/training room	300	28
One supervisor's office	150	14
One mechanics' office	150	14
One parts storage room	150	14
One lube, oil, grease room	150	14
Welding area	200	19
Tire change/chain area	100	9
Heating and ventilation area	400	37
Bench area	200	18
Wash and steam cleaning bay	800	74
Two repair bays	2,000	186
One sand storage room	400	37
One salt storage room	400	37
One urea storage room	400	37

	SQUARE FEET	SQUARE METERS
Steam generator area	150	14
Emergency power generator area	280	26
First aid room	280	26
Janitor's closet	100	9
Storage area (Misc.)	450	42
Total (excluding aisle areas)	20,010	1 824

The area needed for vehicles aisles--approximately 6,000 square feet (560 m^2)--depends upon the building configuration. For VIP International, a central aisle building design was chosen for overall efficiency. After adding the aisle area, it is calculated that VIP International needs a building with approximately 26,000 square feet (2400 m^2) of total floor area.

This calculation suggests a building approximately 110 feet wide by 240 feet long (33 m x 73.2 m). Doors and aisles will be 25 feet wide (7.6 m), and there will be a 22-foot (6.7 m) floor to ceiling clearance in the service areas. The layout for this example is shown in figure A1. Although the parking/storage areas may seem narrow, considering the width of large equipment such as plows and sweepers, the sweeper heads or plows will be angled when parked to conserve space and provide adequate clearance.

SAMPLE CALCULATED BUILDING LAYOUT
(CENTRAL AISLE TYPE)



TYPICAL BUILDING FOR 1,600,000 FT² OPERATIONAL CLEARANCE AREA WITH 40,000 OR MORE ANNUAL AIR CARRIER OPERATIONS.

ALL DOORS-25 FT WIDE/20 FT HIGH

Figure A1. Sample calculated building layout

APPENDIX 2. SNOW REMOVAL EQUIPMENT DIMENSIONS

Blowers - Maximum width - 9 feet (2.7 m) minimum - 7 feet (2.1 m)
Maximum height - 13 feet (3.9 m) minimum - 10 feet (3 m)
Maximum length - 30 feet (9 m) minimum - 21 feet (6.3 m)

Sweepers

Towed Type - Maximum width - 16 feet (4.8 m) minimum - 10 feet (3 m)
Maximum height - 7 feet (2.1 m) minimum - 5 feet (1.5 m)
Maximum length (uncoupled from tow vehicle) - 31 feet (9.4 m) minimum - 18 feet (5.4 m)

Pushed Type - Maximum width - 24 feet (7.2 m) minimum - 13 feet (3.9 m)
Maximum height - 13 feet (3.9 m) minimum - 9 feet (2.7 m)
Maximum length - 37 feet (11.1 m) minimum - 24 feet (7.2 m)

Plows - Maximum widths

Rollover	Standard reversable	Large reversable
10 feet (3 m)	16 feet - (4.8 m)	20 feet - (6 m)

Maximum height carrier vehicle - 11 feet (3.3 m) minimum 9 feet (2.7 m)
Maximum length carrier vehicle - 25 feet (7.6 m) minimum 18 feet (5.4 m)

Sand/Urea Spreader Vehicles - Maximum length - 23 feet (6.9 m)
Maximum height - 9 feet (2.7 m)
Maximum height with bed raised - 18 feet (5.4 m)

Tankers - Variable - generally large and custom built.

Graders - Maximum length - 33 feet (9.9 m)
Maximum height - 12 feet (3.6 m)
Maximum width - 10 feet (3 m)

Wheel Loaders - Maximum height - 12 feet (3.6 m)
Maximum length - 20 feet (6 m)
Maximum width - to 20 feet (6 m), depending on blade or bucket equipment

APPENDIX 3. ALTERNATIVE HEATING METHODS

special consideration in the design of any equipment storage facility is to reduce even eliminate utility costs associated with heating the vehicle and material orage areas. Another consideration is to keep entrance ramps, entrance resholds, and fueling/service areas free of ice and snow. Current technology ists that could reduce or eliminate reoccurring utility and de-icing costs. As th primary heating systems, alternative heating systems are installed at the time initial construction.

PASSIVE SYSTEMS (no external power)

a. Earth Heat Pipes. A heat pipe is a simple, maintenance free device transport heat from the earth into a concrete slab. Heat pipes will continuously at a floor slab without external power. In practice, the heat pipes are closely aced groups of epoxy-coated steel pipes sealed at either end. The pipes are parally inserted in the earth through holes drilled from 20 to 40 feet (6 m to 12 m) ep. The pipes are evacuated to low pressure, given a small charge of liquid ammoa, and resealed. The free ends of the pipes are then bent to an approximately rizontal position, forming a lattice of pipe "fingers" across the floor area where at is desired. Concrete is then poured over the heat pipes, embedding them in the oor slab. As long as the temperature of the deep earth is warmer than the floor, e ammonia in the pipes will be vaporized by the heat of the earth, rise and ansport the earth heat to the cold surface of the slab.

b. Liquid as Heat Source. Heat pipes can be inserted into a manifold carrying ter or another liquid warmer than the floor slab. These operate as an analog of e earth heated system but warm fluid provides the heat source. The water system generally more efficient and less complex than systems using other liquids. The quid heat source may be sewage from the airport buildings, a spring, or a stream.

POWERED SYSTEMS.

a. Ground water as heat source. There is a heat pipe which is thermally tuated by pumping a warmer ground water from a source (well) over a heat pipe nifold. The water is then re-injected into the ground or made available for her airport uses. While this requires power for the pump, far less power is conmed than would be required by conventional heat sources.

b. Solar Systems. Applicable solar energy heating systems are:

(1) Solar heated fluid systems. An antifreeze type solution is heated a solar energy collector and pumped through pipes in the floor slabs to raise e indoor temperatures. An alternate practice uses a standard heat pump to ansfer solar energy collected outside the building on a dark panel to a orage reservoir in a hot water heating system.

(2) Solar heated air systems. Room air is circulated by blowers through special solar heat collectors located in building walls or special openings. This type of system provides supplemental heating for work/storage and office spaces at very low cost. Building design can also incorporate passive solar heating principles by using masonry walls to collect and store solar energy during the hours c sunlight which is released during hours of darkness through improved insulating techniques.

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