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AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION

# CHAPTER 14

# YARDS AND TERMINALS[1]

## FOREWORD

This chapter deals with the engineering and economic problems of location, design, construction and operation of yards and terminals used in railway service. Such problems are substantially the same whether railway's ownership and use is to be individual or joint. The location and arrangement of the yard or terminal as a whole should permit the most convenient and economical access to it of the tributary lines of railway, and the location, design and capacity of the several facilities or components within said yard or terminal should be such as to handle the tributary traffic expeditiously and economically and to serve the public and customer conveniently.

In the design of new yards and terminals, the retention of existing railway routes and facilities may seem desirable from the standpoint of initial expenditure or first cost, but may prove to be extravagant from the standpoint of operating costs and efficiency. A true economic balance should be achieved, keeping in mind possible future trends and changes in traffic criteria, as to volume, intensity, direction and character.

Although this chapter contemplates the establishment of entirely new facilities, the recommendations therein will apply equally in the rearrangement, modernization, enlargement or consolidation of existing yards and terminals and related facilities. Part 1, Generalities through Part 4, Specialized Freight Terminals include specific and detailed recommendations relative to the handling of freight, regardless of the type of commodity or merchandise, at the originating, intermediate and destination points. Part 5, Locomotive Facilities and Part 6, Passenger Facilities relate to locomotive and passenger facilities, respectively. Part 7, Other Yard and Terminal Facilities has been moved to Chapter 6, Buildings and Support Facilities as Part 17, Other Yard and Terminal Facilities. Additional information on passenger rail platforms can be found in Chapter 11, Commuter and Intercity Rail Systems.



[1] The material in this and other chapters in the AREMA Manual for Railway Engineering is published as recommended practice to railroads and others concerned with the engineering, design and construction of railroad fixed properties (except signals and communications) and allied services and facilities. For the purpose of this Manual, RECOMMENDED PRACTICE is defined as a material, device, design, plan, specification, principle or practice recommended to the railways for use as required, either exactly as presented or with such modifications as may be necessary or desirable to meet the needs of individual railways, but in either event, with a view to promoting efficiency and economy in the location, construction, operation or maintenance of railways. It is not intended to imply that other practices may not be equally acceptable.

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# INTRODUCTION

The Chapters of the AREMA Manual are divided into numbered Parts, each comprised of related documents (specifications, recommended practices, plans, etc.). Individual Parts are divided into Sections by centered headings set in capital letters and identified by a Section number. These Sections are subdivided into Articles designated by numbered side headings.

**Page Numbers** - In the page numbering of the Manual (14-2-1, for example) the first numeral designates the Chapter number, the second denotes the Part number in the Chapter, and the third numeral designates the page number in the Part. Thus, 14-2-1 means Chapter 14, Part 2, page 1.

In the Glossary and References, the Part number is replaced by either a "G" for Glossary or "R" for References.

**Document Dates** - The bold type date (Document Date) at the beginning of each document (Part) applies to the document as a whole and designates the year in which revisions were last made somewhere in the document, unless an attached footnote indicates that the document was adopted, reapproved, or rewritten in that year.

**Article Dates** - Each Article shows the date (in parenthesis) of the last time that Article was modified.

**Revision Marks** - All current year revisions (changes and additions) which have been incorporated into the document are identified by a vertical line along the outside margin of the page, directly beside the modified information.

**Proceedings Footnote** - The Proceedings footnote on the first page of each document gives references to all Association action with respect to the document.

**Annual Updates** - New manuals, as well as revision sets, will be printed and issued yearly.

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# Part 1

# Generalities[1]

## — 2017 —

### FOREWORD

This part deals with the general conditions, factors, features and requirements which may be basically common to or directly related with the planning, design, construction and function of yards and terminals and their associated facilities.

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[1] References, Vol. 77, 1976, p. 87; Vol. 83, 1982, p. 363; Vol. 84, 1983, p. 417; Vol. 88, 1987, p. 86. Reapproved with Addition of Section 1.5, Summary (2017), 1987

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## SECTION 1.1 JOINT YARDS AND TERMINALS

### 1.1.1 ECONOMY (1982) R(2017)

a. It is not axiomatic that a joint yard or terminal under one management can be operated more economically and satisfactorily than two or more separately operated yards or terminals of the same aggregate capacity.

b. In a joint yard or terminal, a single organization should control all construction, operation, maintenance and other activities within the terminal zone. All employees, including those of the participating railways, while functioning within the yard or terminal zone should be subject to the control of the appropriate officers.

### 1.1.2 ANALYSES (1982) R(2017)

a. A joint yard or terminal should not be undertaken without thorough analyses of what may be attained in expedition, economy and convenience, under the arrangements to be surrendered and under those proposed.

b. A joint yard or terminal may be undertaken where analyses justify anticipation of its economy as compared with other available alternatives, or where governmental authority or popular demand has substantially the force of mandate.

### 1.1.3 AGREEMENT (1982) R(2017)

A joint terminal agreement should anticipate and definitely cover all relationships between and among the owners, the users and the management of the joint facilities. With a view to discovering weaknesses and omissions which may be overcome in a new agreement, it will be found helpful, before drafting it, to examine existing agreements and consult those charged with their administration.

## SECTION 1.2 ENVIRONMENTAL PROVISIONS (2017)

a. Any yard and terminal design must consider the environmental factors and provide for the minimum controls established and required by federal, state and local laws, directives and ordinances, as applicable to each specific project. Some factors to consider include:

- Post Construction Stormwater management
- Construction stormwater
- Wetlands and streams
- Traffic

- Air quality
- Noise
- Threatened and Endangered Species Habitat
- Groundwater contamination
- Soils removal
- Operational permits
- Existing land use
- Population demographics

b. Planners and designers must work closely with those having expertise in environmental policies and procedures to establish a list of potential environmental factors to be considered early in the project planning / design stages. A full understanding of requirements early in the project will reduce the risk of unexpected design changes, unscheduled delays, and cost escalation.

c. Post construction stormwater management must be considered during planning and design. Most projects will require detention or retention of stormwater to maintain peak outflow or total volume from a site to less than or equal to pre-developed conditions. Stormwater storage can require significant areas of a site to be dedicated for that purpose. Proper planning and design for stormwater storage will help to develop accurate facility capacity projections and prevent unexpected decreases in capacity later in the project. The design should also consider the potential for groundwater contamination, and mitigations should be developed and implemented if necessary.

d. Construction stormwater management must take local regulations into account. In some locales, construction stormwater regulations require permanent Best Management Practices, which can affect final facility configuration and costs. It is important to understand these requirements upfront in order to account for costs and design configuration.

e. If at all possible without negatively impacting safety or operations, measures should be taken in planning and design to avoid environmentally sensitive areas, such as wetlands, streams, or critical habitat areas. If avoidance is not possible, proper mitigations must be developed through coordination with the applicable regulatory agency.

f. Traffic, air quality, and noise studies may be required based on the size, type, and location of the project.

g. The potential for contaminated soil should be evaluated. If contaminated soil is present options include removal or leaving the soil in-place. The soil should be classified to determine the level of contamination and types of contaminants in order to develop a proper management and mitigation plan.

## SECTION 1.3 SAFETY (2017)

### 1.3.1 LIGHTING (2017)

Consideration should be given to lighting based on the tasks and operations being performed. Additional information can be found in AREMA Volume 3, Chapter 33, Part 10.

## 1.3.2 FIRE PROTECTION (2017)

a. Fire hydrants should be located near buildings as required by the current applicable building code. The design should also consider various other points within the yard or terminal where hydrants may be beneficial. The local Fire Protection District should be consulted early in the design process with regards to hydrant locations, fire lanes, and emergency access points. Care should be taken to locate fire hydrants outside the path of traffic. In some cases, protection of hydrants in the form of bollards or some other physical barrier may be warranted.

b. Consideration should be given to future expansion when placing water mains and hydrants. This may not be done if the cost is significant.

c. Water mains should be built in loops, if practicable.

d. Chemical extinguishers should be conveniently placed to afford protection, especially against oil and electric fires.

e. Fire lanes should be provided for access to all buildings by firefighting equipment.

## 1.3.3 FIRE PREVENTION (2017)

a. Consideration should be given to fire prevention, including equipment access and fire prevention planning.

b. Consider local and national fire codes in planning and design.

c. Car handling guidelines should be considered, along with water access and firefighting procedures. These may differ from local applicable codes so it is suggested that local fire officials be consulted on such exceptions.

d. Considerations in fire prevention should include the following:

- Railroad rules and guidelines regarding fire prevention
- A regular program of weed and brush control
- Location and type of fuel storage tanks
- Materials stored in areas free of unnecessary flammable materials
- Waste materials be placed in designated areas and be disposed of regularly
- Procedures be in place for employees required to use welding and cutting torches

## 1.3.4 BUILDING FIRE PROTECTION (2017)

a. In the design of all new buildings or in remodeling existing buildings, local building codes must be considered for fire protection criterion. Refer to AREMA Manual Chapter 6, Buildings and Support Facilities for additional recommended practices on fire protection in railroad buildings.

b. A program of regular maintenance is suggested for building and surrounding areas to prevent fire hazards. Items for consideration are:

- Flammable material storage
- Fuel Storage

- Weed and brush control
- Heating plant
- Electrical wiring

c. Local fire codes prescribe various types of alarm systems depending on the type of building and the building's use. These types may include:

- Smoke detectors
- Flame or heat detectors
- Manual set within building
- Automatic set within building
- Remote alarm (fire department and/or company security)
- Remote alarm by building location (computerized)

d. Local fire codes normally provide for the number and type of extinguishers required depending upon building type size and use. A program to regularly check and recharge the extinguishers, if necessary, should be established. It is important that the type of chemical extinguishers used will provide protection against expected types of fires while minimizing damage to computers and other expensive electronic equipment.

e. Water sources available for firefighting may come from any of the following sources:

- Water main
- Well
- Surface water
- Tank storage

f. One or more of these sources may be provided in design depending upon local fire codes and availability. Consideration should be given to the distances of hydrants or other water sources from buildings to provide proper water pressure and volume. It is suggested that water sources be identified to employees and local fire departments through the use of maps or prints.

g. Buildings are normally accessible by road, however, access roads should be designed to accommodate fire trucks. Road width, turning radii, and railroad crossings should be considered. Procedures should be established to cut crossings for immediate emergency access.

## 1.3.5 ROLLING STOCK FIRE PROTECTION (1987) R(2017)

a. If a car(s) has started on fire it is essential that before anyone gets near the car(s) that the commodity burning be identified. This information is necessary in determining how to handle the car and is information necessary for the fire department to extinguish the fire properly. Once the commodity is identified and known to be safe for movement, it is suggested that a procedure be available and known to affected employees on how the car will be handled. This should be done with the use of buffer cars between the engine and burning car(s). The crew should take the car(s) to a predetermined location for firefighting, possibly an isolated spur track.

b. It is suggested that one responsible company officer be designated during a fire to coordinate activities with the fire department. Instructions should be in place for quick, accurate notification of the fire department. The fire department should be advised of the commodity burning, the exact location of the car(s), and any other relevant information.

c. As in building accessibility, access for fire trucks to yard locations should be considered in design. These should include width of roadways, turning radii for fire trucks, and instructions for clearing crossings. It is suggested that this may be coordinated in advance of any emergencies with local fire officials.

d. As in building fire protection, an adequate water source for rolling stock firefighting should be considered. The source(s) may be integrated into overall plans for fighting fires of rolling stock. In any case, it is suggested that local fire codes be reviewed for hydrant locations and pressure and volume requirements. It is likely that classification yard needs are considerably different from fire codes covering heavy industrial areas, so it is suggested that fire officials be consulted.

### 1.3.6 EMERGENCY PLANNING (2017)

In design and planning of yard areas it is suggested that a definite plan of action be established for emergencies. this may include written instructions which are distributed to key employees outlining what action be taken including notification of emergency response personnel, handling of cars, clearing crossings, and most importantly, employee conduct for safety. It is suggested that in any emergency prevention plan that regular communication be maintained with emergency response officials. They may be informed of usual commodities handled and changes to building or yard areas, so that they can provide the best protection possible.

### 1.3.7 WORKER SAFETY (2017)

a. Consideration should be given in the design to minimize areas with high potential for slips, trips and falls.

b. At all time during the design development, exercise precaution for the protection of persons and property. The safety provisions of applicable laws, building and construction codes shall be observed.

## SECTION 1.4 SECURITY REQUIREMENTS (2017)

### 1.4.1 GENERAL (2017)

a. Protective measures against potential theft and vandalism should be considered in the design of each facility or project. Designs should consider local conditions, facility needs, applicable Government requirements, and input from applicable local authorities.

b. Site designs should also maximize visibility throughout the facility to reduce potential blind spots or dark corners.

c. A report on the subject of theft and vandalism is contained in the Proceedings, Vol. 75, 1974, pages 609 to 611, incl. Information on this subject may be obtained from the Transportation Research Board, National Academy of Sciences, Washington, DC, report No. 487, “Crime and Vandalism in Public Transportation.”

### 1.4.2 LIGHTING (2017)

a. Consider adequate lighting levels and consistency based on the desired level of security. Additional information can be found in AREMA Volume 3, Chapter 33, Part 10.

b. Security lighting should consider illumination levels near all fence lines and behind structures or parking areas.

### 1.4.3 SECURITY CAMERA SYSTEMS (2017)

a. Locate fixed cameras at every facility entrance. Pair fixed cameras with Pan-Tilt-Zoom (PTZ) cameras for maximum flexibility.

b. Head-end server equipment should be capable of future expansion.

c. Locate perimeter security cameras with overlapping sight lines along all fence lines.

d. Limit access to communications center/room. Include access controls and cameras to monitor entry and exit.

### 1.4.4 SECURITY BARRIERS (2017)

a. Utilize proprietary security fasteners on all perimeter fences. Consider site conditions and landscaping needs in the selection of fencing or barriers.

b. Maintain space for a clear strip on the outside of fence lines wherever possible, for maintenance and security purposes.

## SECTION 1.5 SUMMARY (2017)

The recommendations provided in this chapter generally apply to a wide variety of yards and terminals. A specific type of yard or terminal may have additional requirements not contained in this section. More detailed information may be found in the following parts of Chapter 14.

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# Part 2

# Freight Yards and Freight Terminals[1]

## — 2019 —

## FOREWORD

This part deals with the engineering and economic problems of location, design, construction and operation of all the facilities provided by a railway company, or by railway companies in common, or acting jointly, as the case may be, to handle freight to or from or through and within a given district on behalf of such railway company or companies.

Conditions of demand and feasibility vary widely, and generally each case of constructing an altogether new layout on a large scale, or of remodeling or consolidating an extensive existing layout, constitutes an essentially basic problem.

Each of these features and its appurtenances, with a full knowledge of the average and maximum demands to be made upon it, must be carefully designed to fulfill its particular functions expeditiously and economically.

The designation "freight yard" (sometimes called marshalling yard) and "freight terminal" as used herein are only relative to their location within a railway system, have similarity in meaning and may perform like functions. The term "yard" as opposed to "terminal" may be used in a certain interpretation or within a certain geographical area to designate an essential unit, a supplementary adjunct or a tributary to a terminal.

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[1] References, Vol. 77, 1976, p. 87; Vol. 83, 1982, p. 363; Vol. 84, 1983, p. 98; Vol. 89, 1988, p. 188; Vol. 94, p. 85; Vol. 96, p. 65. Adopted 1976.

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## SECTION 2.1 INTRODUCTION

### 2.1.1 GENERAL (2018)

a. To meet traffic requirements a yard or terminal should be able, even in peak periods, to receive trains promptly upon arrival, perform any auxiliary service (such as weighing, making running repairs, etc.), switch cars into their proper classification without appreciable delay, and dispatch these cars in their proper position in outgoing trains in minimum time.

b. The number of yards should be as few as is consistent with the efficient handling of traffic.

c. An additional yard is warranted only when it will result in greater economy than the enlargement or reconstruction of an existing yard or yards.

d. Yard or terminal layouts should provide for future expansion so that the number and length of the tracks in them may be increased as required with minimum interference with operation or minimum relocation of existing trackage.

e. An existing yard or terminal which is inadequate to handle the current or immediately anticipated traffic should be enlarged, or redesigned and rebuilt, or retired in favor of a yard or terminal in a different location, according to which of these alternatives will result in the greatest economy. The property and other requirements for yard expansions and new yards can be substantial, may take years to secure, and be costly at some locations. Property acquisition, utility relocations, roadway relocations, and permitting, among other requirements, should be evaluated when comparing alternatives between new yards, expansion of existing yards, and other alternatives that may be appropriate.

f. With the advent of articulated rail cars it is difficult to establish an average car length to determine track car capacities. Single car lengths generally vary from 40 feet (12 m) to over 95 feet (29 m) while some articulated intermodal cars exceed 300 feet (91 m) in overall length. Therefore average car lengths do not have as much purpose as they once did in yard design unless the same type of equipment is to be switched in the yard. A determination needs to be made on car types before track capacity can be established

g. Yard lighting is desirable. The economical distribution of light over the area involved, so as to provide proper intensity of illumination, requires careful design. Chapter 33, Part 10 of the Manual for Railway Engineering (MRE) provides guidance for lighting and should be consulted.

h. A properly designed and maintained drainage system is essential. Because most yards are flat or bowl-shaped to achieve operational criteria, drainage is inherently going to require special consideration. Pervious roadbed materials and a subsurface drainage network should be considered when designing an effective drainage system. Where applicable, local permitting requirements for stormwater management and/or treatment should be investigated early to allow design development to accommodate permitting requirements.

i. Signal and communication systems, such as control signals, power operated switches and derails, radios, intercoms, pagers, talkback speakers, telephones, closed circuit television, AEI and other devices should be considered to expedite yard and terminal operations.

j. Vehicle roadways and walkways provide important access for the efficient operation of a yard and should be considered when designing new or expanded yards. Access requirements should consider building locations, maintenance requirements, train crew hauling, switching crew movements, locomotive fueling, train inspections, and other possible needs.

## SECTION 2.2 TRACK ARRANGEMENT

### 2.2.1 GENERAL (2019)

a. Main tracks should bypass yards.

b. Connections to the main track from the receiving, classification or departure tracks should be as direct as practicable.

c. Turnout sizes should be selected based on desired track speed, frequency of use, and maintainability.

d. Crossovers should be provided as required to facilitate all normal and regular movements in the yard or between the yard and main track, and so located to result in minimum interference between simultaneous movements.

e. In order to keep the distance to clearance to a minimum, the angle between a ladder track and the body tracks should be as large as possible.

f. Ladder tracks should be spaced not less than 15 feet (4.5 m) center to center from any parallel track, and when such parallel track is another ladder track, they should be spaced not less than 20 feet (6.1 m) center to center. The requirements of governing bodies must be observed and access requirements should be considered.

g. Body tracks should be spaced not less than 14 feet (4.2 m) center to center, and when parallel to a main track or important running track, the first body track should be spaced at least 15 feet (4.5 m) center to center from such tracks; however, this is subject to state regulations on clearances.

h. Hump pull backs and Trim tracks should be kept clear of other movements within the yard.

i. Locomotives need access between the service area and Receiving and Departure Yards.

## SECTION 2.3 YARD COMPONENTS

### 2.3.1 RECEIVING YARD (2018)

a. The number of receiving tracks should be sufficient to accommodate arriving trains. Parameters to consider include arrival frequency, train length, and dwell time before moving on to classification or loading/unloading tracks. Providing additional tracks to account for possible surges in traffic due to derailments, natural disasters, or unusually heavy traffic should be considered, as having these features will help the yard remain operationally flexible during abnormal operating conditions.

b. The length of receiving tracks should be such that each will accommodate a complete train, including assisting locomotives where used. Additional considerations for track length include the locations of road crossings, derails, signals, or other optional yard apparatus which will impact the amount of track that a train can occupy. This amount of track should be added to the design train length to determine the total track length. For Receiving Yard that frequently

may deal with shorter trains, adding crossovers at the mid-points of some tracks or some shorter length tracks can allow more efficient allocation of yard space. When track lengths cannot accommodate complete train lengths, consideration should be given to provide yard leads that allow for doubling in without occupying the main track.

c. The gradient of the receiving track should be such to avoid the need for hand brakes. While hand brakes may still be utilized for safety, flat or bowl shaped track profiles will reduce the risk of roll-outs. Topography can be a driving factor in the location of the Receiving Yard.

d. For larger Receiving Yard that will deal with many trains per day, as well as Receiving Yard located along heavily used mainlines, consideration should be given to having signalized entrances to the yard. These may include power turnouts and derails, bonded tracks to convey occupancies to the yard controller, or specific control points at the ends of the Receiving Yard. The benefit of these features is that they allow greater efficiency in yard operations and greatly reduce the amount of time the mainline is blocked when a train is entering the yard.

e. If motorized inspection is planned, sufficient width between tracks should be provided to permit passage of vehicles used for such inspection. Paved or aggregate surfacing, along with appropriate drainage structures, should be provided, with the top of the surface located at or near the top of tie elevation to facilitate walking from a vehicle to the rail car. It may be desirable to provide overhead lighting. Consideration should be given to vehicle crossings to facilitate access between the tracks. Track spacing should also allow for any type of utilities that may be located between the tracks. This could include signal equipment, electrical transformers, light poles, or yard air connections.

## 2.3.2 CLASSIFICATION YARD (2018)

a. The type of yard which should be adopted in any given case depends upon the volume and character of traffic to be handled through it, and the train schedules. The decision should be based on a thorough traffic analysis and economic study.

   (1) A single flat yard is adapted for handling traffic where the total number of cars is small and the number of switching cuts per train is also small.

   (2) A double flat yard is adapted for handling traffic where the total number of cars is large but the number of switching cuts per train is small.

   (3) A gravity yard or a hump yard is adapted for handling traffic where the total number of cars is large and the number of switching cuts per train is also large - also in special cases where the total number of cars is relatively small but normally received in a short period of time, and the number of switching cuts per train is large. See Section 2.4 Hump Classification Yard Design (Full Automatic Control).

   (4) In special cases due to the location of the yard, the character of traffic, or the arrangement of schedules, it may be necessary to provide a double flat yard or a double hump yard, because of limited time for handling.

b. The number of classification tracks should be such that there will be at least one available for each important classification. Where cars of single classification do not accumulate enough to be assigned a separate track, the design features should permit re-hump or stage switching to make the required blocks.

c. The length of classification tracks should be such that each will normally hold all accumulated cars of the assigned classification until they are to be moved off the classification track under normal operation.

d. Prevent rollout grades should be provided on all Classification Tracks as a safety precaution against uncontrolled rail cars rolling out of the classification track. Inert retarders, can be utilized as a further safety precaution to control rail cars, and track protection circuits or camera monitoring systems can be utilized to detect when cars may be fouling other tracks.

## 2.3.3 DEPARTURE YARD (2018)

a. Departure tracks may be located alongside or at the end of the classification tracks. A Departure Yard that has the capability of being used as an alternate Receiving Yard can be very desirable, as the ability to receive trains on these extra tracks provides greater flexibility in times of service disruption or other operational anomalies where the number of trains needing to enter the yard temporarily exceeds the number of dedicated Receiving Tracks.

b. The number of departure tracks should be such that there will be one available for assembling a departing train whenever necessary.

c. The length of departure tracks should be such that each will accommodate a complete train, including assisting locomotives where used. Additional considerations for track length include the locations of road crossings, derails, signals, or other optional yard apparatus which will impact the amount of track that a train can occupy. This amount of track should be added to the design train length to determine the total track length. When track lengths cannot accommodate complete train lengths, consideration should be given to provide yard leads that allow for doubling out without occupying the main track. Consideration should also be given to accommodate setting out bad-order cars without occupying the main track.

d. The gradient of departure tracks should be as level as possible. Further analysis and concurrence may be necessary from the operating railroad in the situation that terrain or economics dictates a grade greater than 0.25%.

e. Compressed air at suitable pressure should be piped along the departure tracks, and sufficient outlets should be provided to permit the testing of the air brake equipment on the cars of departing trains. The volume of air required and the power source should be sufficient for proposed yard operations. See AREMA Manual for Railway Engineering (MRE) Chapter 6 for design parameters.

f. Consideration should be given to the installation of shove indicators located at clearance point of each departure track. These allow single man switch crews to stop their train prior to fouling the clearance point of each track.

g. If motorized inspection is planned, sufficient width between tracks should be provided to permit passage of vehicles used for such inspection. Paved or aggregate surfacing, along with appropriate drainage structures, should be provided, with the top of the surface located at or near the top of tie elevation to facilitate walking from a vehicle to the rail car. It may be desirable to provide overhead lighting. Consideration should be given to vehicle crossings to facilitate access between the tracks. Track spacing should also allow for any type of utilities that may be located between the tracks. This could include signal equipment, electrical transformers, light poles, or yard air connections.

## 2.3.4 REPAIR YARD (2018)

a. a. The location of the car repair yard should be such that the movement of bad-order cars will be as direct as practicable, that switching the repair yard will not interfere with other work, and that repaired cars may be returned readily to the classification or Departure Yard, as required.

b. The capacity of the repair yard depends on the number of cars to be repaired daily. Tracks should be as short as possible. In computing the capacity of the track holding the cars, the types of cars to be repaired needs to be identified first before car length capacity can be determined. Single car lengths generally vary from 40 feet (12 m) to over 95 feet (29 m) while some articulated intermodal cars exceed 300 feet (91 m) in overall length. If no articulated cars or extreme length cars are to be repaired, an average car length of 55 feet (16 m) to 60 feet (18 m) can be considered for track capacity.

c. Repair tracks should be connected at both ends where feasible. The tracks may be alternately spaced on narrow and wide centers, the narrow spacing to be not less than 18 feet (5.5 m) to allow repair personnel access and the wide spacing may be 40 feet (12 m) or more to accommodate motorized equipment, such as forklifts working perpendicular

to the tracks, or large boom / hoist trucks, etc. Jacking pads should be considered at one or more locations for jacking cars when working on trucks and wheels.

d. A paved driveway should be considered between the repair tracks with wide centers, and paving is also desirable between the tracks with the narrow centers. The elevation of the driveway is usually the same as the top of rail. Crossings should be spaced at approximately 8-car intervals or similar to allow ready vehicular access to the repair area without needing to drive around long cuts of cars.

e. Consideration should be given to a "one-spot" repair yard, where cars are moved by mechanical means to the repair building, one at a time, repaired and removed. This system is usually adaptable to one or more tracks.

f. Material storage area requirements, such as for wheel sets, etc., should also be considered when determining repair yard track location and size.

g. Blue flag or similar protective or warning measures should be utilized for the safety of carmen in the repair yard. When live tracks are in the vicinity of the repair yard, a fence may be needed for the safety of the carmen.

## 2.3.5 LOCAL YARD (2018)

a. A local yard may be defined as one which handles cars to nearby destinations and from nearby origins. It generally acts as a sub-terminal and is often part of, or attached to, another Terminal Yard. The local yard should provide tracks to stage cars for delivery to local destinations. A switching lead should be included for further classifying of the cars in these tracks. Classifications of the local yard should not impact other yard operations. While the local yard will generally follow the flat yard design guidelines, it is possible to use a mini hump for gravity switching these sub yards.

b. Extra care must be taken in its design because insignificant changes in industry switching patterns, traffic volumes and through train scheduling may have considerable impact on the efficiency of its operation.

## 2.3.6 MISCELLANEOUS YARD TRACKS AND FACILITIES (2018)

### 2.3.6.1 General

All miscellaneous tracks should be located so that the use of them will cause minimum interference with other operations in the yard, particularly road trains entering and leaving the yard.

### 2.3.6.2 Switching Leads

Switching leads should be designed to give the enginemen working on them a clear view of switchmen passing signals along the ladder track. This may not be necessary where yard crews are equipped with engine-to-ground radio communication. Multiple parallel leads with well-placed crossovers should be provided where traffic is heavy to facilitate multiple simultaneous movements.

### 2.3.6.3 Caboose Tracks

The use of cabooses has generally been discontinued on Class I railroads. However, if there is a need to provide caboose tracks, they should be double-ended and located so as to permit easy access to departure tracks.

### 2.3.6.4 Wrecker Equipment Track

A double-ended track for the storage of the wrecker or other maintenance of way equipment should be considered.

#### 2.3.6.5 Other Tracks

a. Lead tracks should be provided for both Receiving and Departure Yards, and should be somewhat longer than the maximum train length to allow trains space to clear the mainline at speed with appropriate deceleration distance and to temporarily hold a train due to the yard or mainline being unable to accept them.

b. Running tracks should provide access to all parts of the yard and between the locomotive terminal and the yard.

c. Scale tracks, if needed, should be so located to permit the weighing of cars with minimum delay to yard operation. A common location is between the Receiving and Classification Yards, as most if not all cars in the yard will move between these yards at some point.

d. Storage tracks may be required to ease yard operations where many cars are held to serve local needs, customers, or industries or for temporary storage purposes. These tracks ideally should have good access to the departure and Classification Yards.

e. Tracks may be provided in hump yards for bypassing the hump with certain cars, or to provide an "escape" route from the retarder area to the Receiving Yard for hump engines. See Section 2.4 Hump Classification Yard Design (Full Automatic Control).

f. Tracks should be considered for equipment staging or material loading/unloading for Maintenance of Way department.

g. Turning tracks, such as a wye or balloon track, or a turntable should be located in a practical location for turning locomotives without impacting yard operations. Ideally this will be close to the locomotive servicing area.

#### 2.3.6.6 Locomotive Fueling, Sanding and Servicing

Facilities for the fueling, filling sanding chambers and servicing of locomotives should be provided as outlined and specified in Part 5, Locomotive Facilities, particularly Section 5.1, General and Section 5.2, Servicing Facilities as well as MRE Chapter 6.

#### 2.3.6.7 Allied Facilities

Various types of lading transfer facilities such as intermodal and/or automobile trans-loading facilities may be located in or adjacent to freight yards. A separate analysis should be made of switching needs of each of these facilities so that ready access can be provided between the facility and the freight yard if required.

## SECTION 2.4 HUMP CLASSIFICATION YARD DESIGN (FULL AUTOMATIC CONTROL)

### 2.4.1 GENERAL (2018)

a. A hump classification yard should be designed for the volume and character of traffic to be handled and should provide for continuous movement while humping with minimum loss of time between successive humping operations; also for the movement of cars by gravity from the crest to their proper tracks in the classification yard without damaging impacts.

b. Tracks at the outbound end of the classification yard should be connected to ladders so that classifications normally assembled in one train may be assigned to permit gathering from one ladder, thus providing for minimum movement of trim-end engines. A sufficient number of ladders, with lead connections to departure tracks, should be provided to permit working at least two trim-end engines where required with minimum interference. In many yards the throughput of the facility is determined by the rate you can remove cars from the classification yard; refer to Figure 14-2-1.

c. Where required, a set out track for cars with commodities that are not to be humped (inhalation hazard, explosive, etc.) as well as an escape track to release road locomotives should be installed.

d. Where a second locomotive set for continuous humping is desired a second track from the receiving yard may be required to ensure continuous operation.

e. If trains from two or more directions are to be humped in one direction over the hump, provision should be made so that cars can be moved into the end of the receiving yard next to the hump with minimum interference with humping operations.

f. It may be desirable to make up and dispatch trains from the classification tracks if local conditions permit, and such a method of operation usually expedites movements through the yard and reduces the expense. This requires that a sufficient number of classification tracks be long enough for each to accommodate a full-length outgoing train, or that lead tracks be provided at the outgoing end such that the combined length of a classification track and a lead track be sufficient for a full-length train, thus avoiding unnecessary doubling over or interference with hump operation. This may involve a temporary reassignment of classification during the inspection and preparatory time of a departing train.

g. Departure tracks may be required for making up and dispatching trains, depending on local conditions.

h. The gradient and geometry of a track leading to the crest of the hump should be such as to permit pushing the longest and heaviest train at humping speeds consistent with the proposed available power.

i. A good walkway surface should be provided at the hump crest on both sides of the track for the pin-pullers. If only one walkway for the pin-puller is provided it should be located on the right hand side when moving toward the hump. (It is desirable that cars be uncoupled from the right hand side so that the forward knuckle will be open, as the impact of normal coupling will often close the rear knuckle.)

j. Reference AREMA MRE Chapter 6 for lighting best practices.

k. Tracks can be set with extra wide centers between adjacent groups to give access for maintenance vehicles to move into the body of the yard.

l. Consideration should be given to maintenance of utilities supporting the hump operation. This could include electrical equipment, air valves, air tanks or signal equipment.

m. Two outer roadways running the length of the yard, and parallel with the tracks can be ideal to facilitate ease of vehicle movements from one end of the yard to the other.

n. Tracks can be set with extra wide centers between adjacent groups to give access for maintenance vehicles to move into the body of the yard.

o. The outer and inner roadways can be connected across the yard by constructing level grade road/rail crossings at the narrow ends of the track layout and where the minimum number of tracks need to be crossed.

p. For movement across the yard at the hump-end a tunnel may be constructed under the hump itself.

q. Grade crossings in classification yards, when necessary, should take into consideration type and volume of traffic.

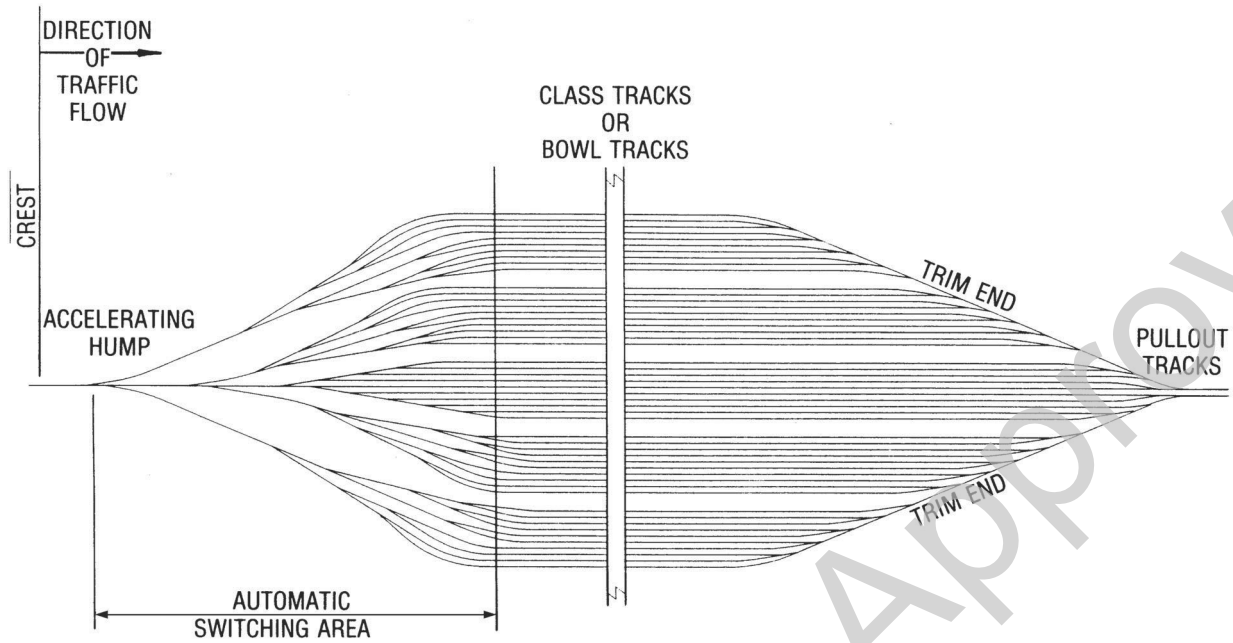



***Figure 14-2-1. Typical Classification Track Layout***

r. Adequate car parking facilities for employee and company vehicles at the various office and workshop locations should be a consideration.

s. If the identification numbers of incoming cars are to be read and recorded by a video camera system, then special purpose high-density illumination should be provided at the camera location.

t. Modern automated hump classification yards fall into two principal categories, Intermittent Car Speed control or Continuous Car Speed control systems. A third category can be a hybrid system which combines Intermittent and Continuous control systems.

(1) Intermittent Car Speed Control System

(a) Intermittent car speed control systems in which powered, electronically supervised clasp retarders are located at discrete positions to control the velocity and progress of the cars traveling through the yard.

(b) The position and speed of the cars is constantly measured, monitored and predicted by the electronic supervisory system which commands the modes of the clasp retarders.

(c) The principal retarders, located in the switching area, are usually powered electrically or pneumatically.

(d) Other types of supplementary retarders may be needed such as tangent point retarders located at the entrances to the classification tracks, and operable skate retarders located at the exit ends of the tracks to provide securement other than tying hand brakes.

(e) The automatic control of the switches, to route the cars into classification tracks, is controlled by the supervisory system along with other operational functions.

(2) Continuous Car Speed Control System

(a) Continuous car speed control systems in which speed sensitive hydraulic retarder units are distributed as necessary to tracks to automatically control the velocity of the cars traveling through the yard. Application in curves should be avoided if at all possible.

(b) This type of retarder is self-contained and needs no exterior power supply or electronic supervisory system.

(c) These retarders are mounted in close proximity along the tracks from the hump, through the switching area and for a selected distance down into the classification tracks.

(d) An electronic control system is needed for automatic switch operation and to supervise other operational functions.

(3) Hybrid System

(a) A hybrid system that combines an intermittent control system with a continuous control system, paragraph (1) and paragraph (2), can be employed to develop a yard having high car speeds in the switching area and accurate coupling speeds in the class tracks.

(b) In such a yard design the velocity and progress of the cars in the switching area would be controlled by an intermittent car speed control system. The function of this part of the hybrid system would be to ensure adequate separation between cars so as to permit movement of the switches for routing; and to predict, monitor and control the speeds for the cars arriving at the classification tracks.

(c) The velocity of the cars in the classification tracks would be controlled by a continuous car speed control system. The function of this part of the hybrid system would be to ensure a maximum allowable coupling velocity of the cars, to promote full car closure in the tracks and to prevent car runouts from the trim-end.

## 2.4.2 INTERMITTENT CAR SPEED CONTROL (2017)

### 2.4.2.1 Hump Control Tower and Buildings

a. A control building can be located near the hump to house operators and offices. This control building should contain video systems or other methods to allow the operators a good overall view of traffic movements throughout the yard.

b. The control building may need to accommodate a variety of facilities such as:

(1) A control room, in which to locate a control panel for the manual operation and monitoring of signals, switches and retarders. Operational offices with associated communications, signaling and hump process control systems.

(2) Hump process control room and electrical power supply equipment with their required cable routes and ducting.

(3) Utility services equipment for the building.

(4) Staff amenities accommodation.

c. See AREMA MRE Chapter 6 for additional information on building design considerations.

### 2.4.2.2 On Track and Trackside Equipment - Refer to Figure 14-2-2

To support a central process controller it may be necessary to install a variety of peripheral hardware at locations on the track.

#### 2.4.2.2.1 Car Identification Equipment

This may be a video camera system or an Automatic Equipment Identification (AEI) system to interrogate car mounted identification.

#### 2.4.2.2.2 Hump and Trim Signal

To control train movements toward the hump crest.

#### 2.4.2.2.3 Car Characteristics Identification Equipment

a. Pole mounted photoelectric cells and track mounted wheel detectors to monitor car cut lengths.

b. A weigh rail installed in the track to measure axle loads

c. Wheel Detector System or Radar System to form a rolling resistance test section.

d. Radar speed detectors to monitor car speed.

#### 2.4.2.2.4 Track Scale

A weigh in motion scale for the commercial weighing of cars. Weight information can also be for input to car speed control system. The scale would need to be installed on a suitable foundation.

#### 2.4.2.2.5 Car Speed Control

a. Primary, intermediate, group tangent point retarders mounted in the track to control the speed of cars at strategic locations. These can be electrically or pneumatically powered.

b. An electrical supply facility to power electrically powered retarders can be constructed in the vicinity of the retarders.

c. Air supply facilities for pneumatic retarders should be located in a position to limit piping run but far enough to prevent potential intake fouling.

#### 2.4.2.2.6 Switches

Powered switches would be needed to route the cars from the crest into the classification tracks. Electrical track circuits or proximity loops, and/or wheel detectors can be included in the switching area to monitor the progress of the cars and provide switch movement protection as required.

#### 2.4.2.2.7 Distance to Couple

The classification tracks may be equipped with electronic circuits to determine the distance a car must travel to couple.

#### 2.4.2.2.8 Cable Routes

a. All the above signaling and monitoring equipment would require electrical cabling enclosed in trenches, troughs, conduits or directly buried.

b. Trackside electrical equipment cases would be needed at various locations.

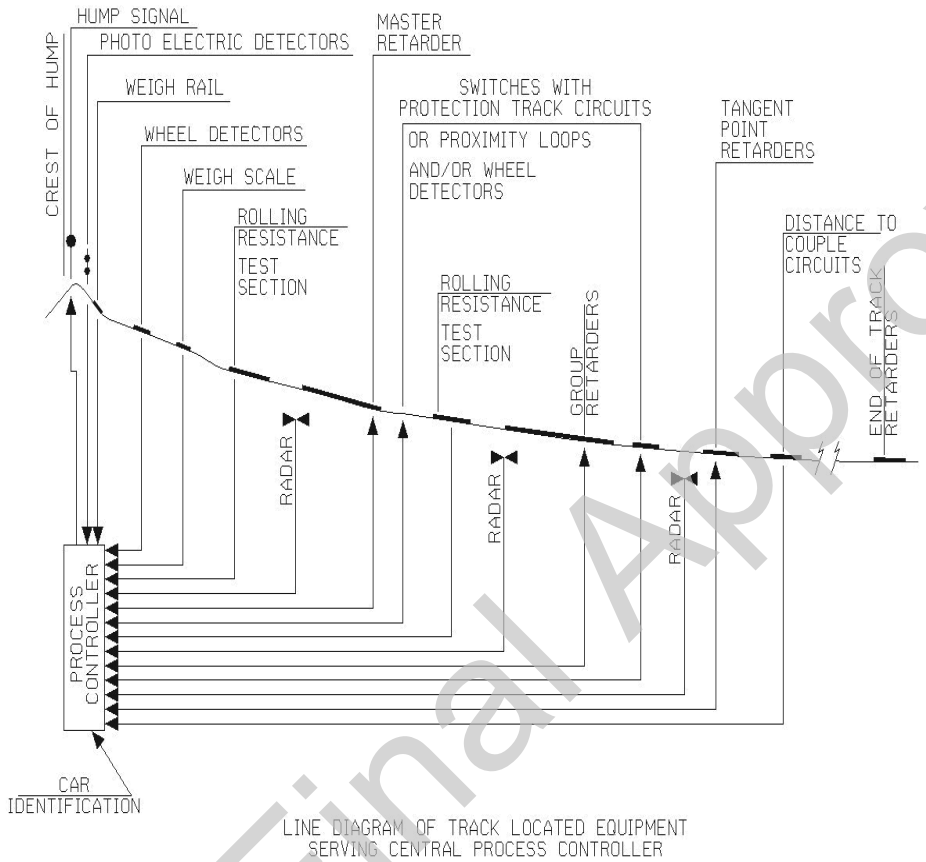



***Figure 14-2-2. Intermittent Car Speed Control System***

### 2.4.2.2.9 End of Track Retarders

These may be used at the trim-end of the classification tracks to provide securement other than tying hand-brakes. Reference Figure 14-2-4.

### 2.4.2.3 Trim-End Tower or Building

a. In large yard developments with extended classification tracks, a trim-end building may be required to house signal and traffic control room from which operations in the departure end of the yard may be supervised. See AREMA MRE Chapter 6 for additional information on building design considerations.

b. The trim-end building may need to contain a number of facilities such as:

(1) A signal and control room with signaling and communications equipment.

(2) An electrical power supply equipment room with their required cable routes.

(3) Utility services equipment for the building.

(4) Staff amenities accommodation.

## 2.4.3 CONTINUOUS CAR SPEED CONTROL (2018)

### 2.4.3.1 Hump Control Buildings

a. A control building can be located near the hump to house operators and offices. See AREMA MRE Chapter 6 for additional information on building design considerations.

b. The functions of this building could be similar to that described in Article 2.4.2.1 with the following exceptions:

(1) There is no manual or automatic control of this type of retarder.

### 2.4.3.2 On Track and Trackside Equipment - Refer to Figure 14-2-3

a. Car identification equipment as per Article 2.4.2.2.1.

b. Hump and trim signals as per Article 2.4.2.2.2

c. Multi-unit Hydraulic Retarder system consists of self contained, hydraulically operated devices that require no external power source and bolted to rails at close intervals throughout the tracks as per Article 2.4.1.t.(2).

d. Switches as per Article 2.4.2.2.6.

e. Cable routes. The signaling and track circuit equipment would require cabling as per Article 2.4.2.2.8.

### 2.4.3.3 Trim-End Tower

In large yard developments a trim-end tower may be required as described in Article 2.4.2.3.

## 2.4.4 HYBRID CAR SPEED CONTROL SYSTEM (2017)

### 2.4.4.1 Hump Control Buildings

a. A control building can be located near the hump to house a control tower, operators and offices.

b. The description and functions of this building would be similar to that described in Article 2.4.2.1.

### 2.4.4.2 On Track and Trackside Equipment

a. To support the Intermittent Car Speed Control part of the system it may be necessary to install in the switching area a variety of peripheral hardware at locations on the track.

b. For a description of the type of equipment that may be included refer to Article 2.4.2.2.

**NOTE:** Article 2.4.2.2.9, end of track retarders may not be required.

c. For the Continuous Car Speed Control part of the system hydraulic type retarders would be needed in the classification tracks as described in Article 2.4.3.2c.

### 2.4.4.3 Trim-End Tower

In large yard developments a trim-end building may be required as described in Article 2.4.2.3.

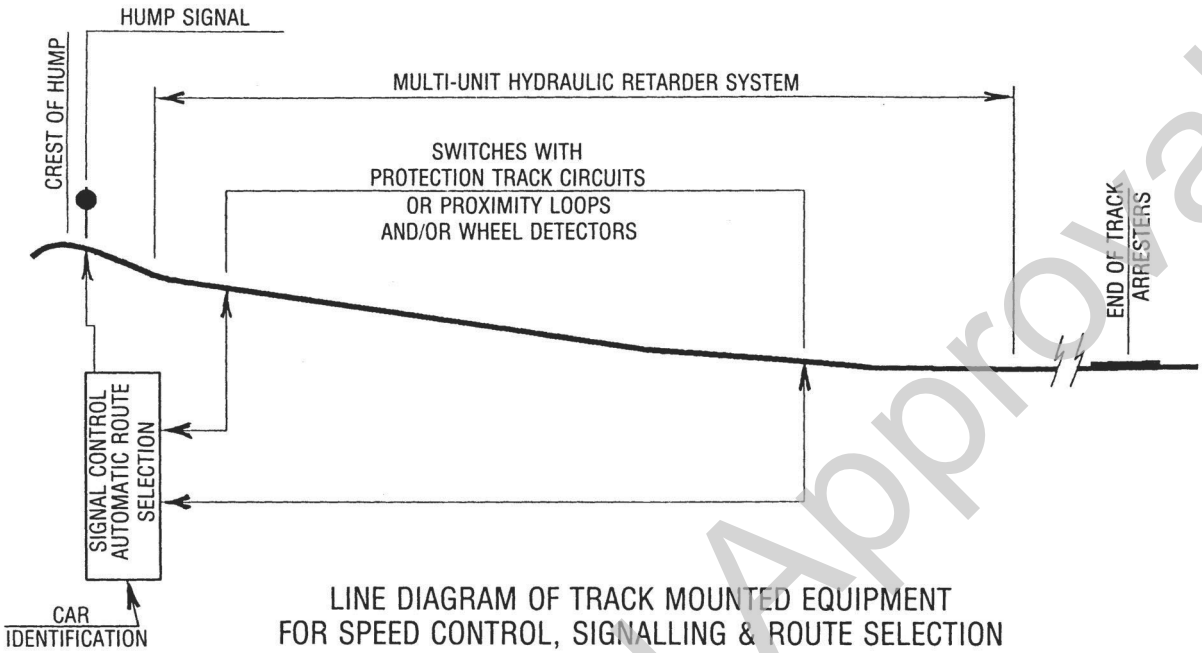



***Figure 14-2-3. Continuous Car Speed Control System***

## 2.4.5 OBJECTIVE (2018)

a. The objective for constructing and equipping an automated hump yard is to facilitate an efficient and expedient method of automatically routing free rolling cars into designated classification tracks for the formation of outbound trains.

b. To achieve this objective it is necessary to meet certain design criteria within the overall concept.

### 2.4.5.1 Design Criteria

a. To provide a hump of sufficient elevation to ensure that all cars, having a practical rolling resistance value will penetrate far enough into the classification tracks to achieve a high percentile of closed couplings. It may be necessary to relax this requirement under severe weather conditions such as extreme cold, snow or high winds; but the minimum need is for all cars to run beyond the clearance points.

b. To form accelerating gradients from the hump that will promote separation between successive cars to facilitate the operation of switches between cars.

c. To form a series of gradients throughout the switching area of the yard so that the car speeds are compatible with the specified humping rate (car throughput) and with the chosen retarder system.

d. To automatically control the velocity and destination of the cars by providing car retarder and route selection systems respectively.

e. To form gradients in the classification tracks that will assist the cars to penetrate the tracks fully and couple at 4.0 mph maximum.

### 2.4.5.2 Design Methods

a. Although it is a range of rolling resistances that influence the gradient profile of a yard, it is the retarder system that assumes the primary role in yard design by the fact of measuring and monitoring the car speeds to achieve the desired throughput, controlling acceleration, maintaining separation in the switching area and determining car performance in the classification tracks.

### 2.4.5.3 Typical Retarder Control Systems

### 2.4.5.3.1 Intermittent Control System

#### 2.4.5.3.1.1 Automatic Yard

a. In an automatic yard employing intermittent retarders and a process controller system the cars are weighed and classified after leaving the crest of the hump. Rolling resistance measurements are taken at one or more test section locations. This information is stored for reference in predicting the car exit velocities from the group and/or tangent retarders.

#### 2.4.5.3.1.2 Primary Retarder

a. The primary retarder is used to adjust the velocity of the cars in order to maintain adequate separation between them; and to assist the speed control function of the group retarders by providing suitable exit velocities from the primary retarder.

b. As a car passes through the primary retarder, the braking shoes are applied at no more than the maximum pressure allowable for the car's weight category. Radar units measure the speed of the car moving through the retarder and transmit information to the process controller in the form of a constant feedback loop to continuously monitor car speed and determine the retardation force required.

#### 2.4.5.3.1.3 Group Retarder

a. The speed control method is the same through the group retarders as for the primary retarder except that in this case the exit velocities must be adjusted for the cars running varying distances down the classification tracks to finally couple at a maximum 4 mph.

b. The rolling resistance value of the car, based upon the information collected at the test sections, is modified in accordance with track and car characteristics. The track resistance characteristics are determined from computer models and practical tests made prior to the system being operational.

c. The classification tracks are equipped with electronic distance to couple circuits which monitor the positions and speeds of the cars and transfer this information to the process controller; from this the exit velocity from the group retarder is determined for each car. This exit velocity will be automatically and continually modified during switching operations to strive to achieve the maximum performance in cars coupled not exceeding 4 mph.

#### 2.4.5.3.1.4 Tangent Point Retarders

a. For some yards, where the distance from the group retarder to the tangent points, and the distances to couple are extensive or increased throughput is desired, it is necessary to employ tangent point retarders to attain the required car performance in the tracks.

b. The exit speeds from the group retarder are then controlled so that the cars arrive with predicted velocities at the tangent point retarders. These retarders, being radar equipped will monitor and control the car speed in accordance with the distance to couple information.

#### 2.4.5.3.1.5 Clasp Type Retarders

a. The clasp type of retarders used in intermittent car speed control systems act upon sides of wheels. The brake shoes apply a frictional force to slow the wheels of the car; this force is controlled in increments that are proportional to the car weight classes.

b. Variations of these types of retarders are:

(1) Pneumatically powered.

(2) Hydraulically powered.

c. A primary or group retarder can be of various lengths and is installed on a well-constructed and consolidated foundation. The mechanical components and associated steelwork are integrated in assembly with special ties that have custom made supports on which the running rails are attached within the retarder. This type of retarder, due to the frictional action at the brake shoe to wheel interface can in some instances emit loud noise levels of high frequency. Dependent upon location, it may be an environmental requirement to construct acoustical barriers in close proximity to the retarders. Maintenance and lighting should be considered in the design of acoustical barriers.

#### 2.4.5.3.1.6 Typical Gradients

Typical gradients associated with this type of yard are illustrated in Figure 14-2-4. In the design of the track profile for a classification yard, the gradients will depend upon factors such as car throughput, range of car rolling resistance values, track curvature and turnouts, and local weather conditions. Due to the steep grades at the crest, it may be desirable to add a short section of +0.50% grade between the approach grade to the crest and the -2.5% grade descending into the classification yard. This will reduce the amount of binding in the knuckles and allow easier uncoupling of the cars. Final design of the gradients in the yard should be modeled to ensure optimal performance for all car mixes.

#### 2.4.5.3.2 Continuous Control System

a. In a yard employing the continuous control method the car velocity for the switching area, i.e. from the hump to the tangent points, is selected during the yard design stage. This switching area velocity is dependent upon the humping rate, separation between cars, range of car rolling resistance values, range of wheel diameters, the track characteristics and the length of the switching area. The hydraulic retarder units are then calibrated during manufacture to control all cars constantly at this selected velocity.

b. Hump.

(1) The hump, for this type of yard will compromise concurrent concave and convex vertical curves and finish at the first switch.

(2) The hump is used to accelerate cars to the switching area velocity and the installation of the retarder units commences in the sag curves at the point where the minimum rolling resistance car attains the switching area velocity.

c. A constant gradient is formed from the first switch to the tangent points in the classification tracks. This gradient is designed for a modified rolling resistance value comprising car rolling resistance plus air, wind and track characteristic resistances. These characteristics, together with the maximum car weight will determine the quantity of retarder units needed to provide continuous speed control.

d. At the tangent points, or in some instances the clearance points, deceleration zones are used to slow the cars from the switching area velocity to a 4.0 mph coupling velocity and are situated on the initial gradients at the beginning of the classification track.

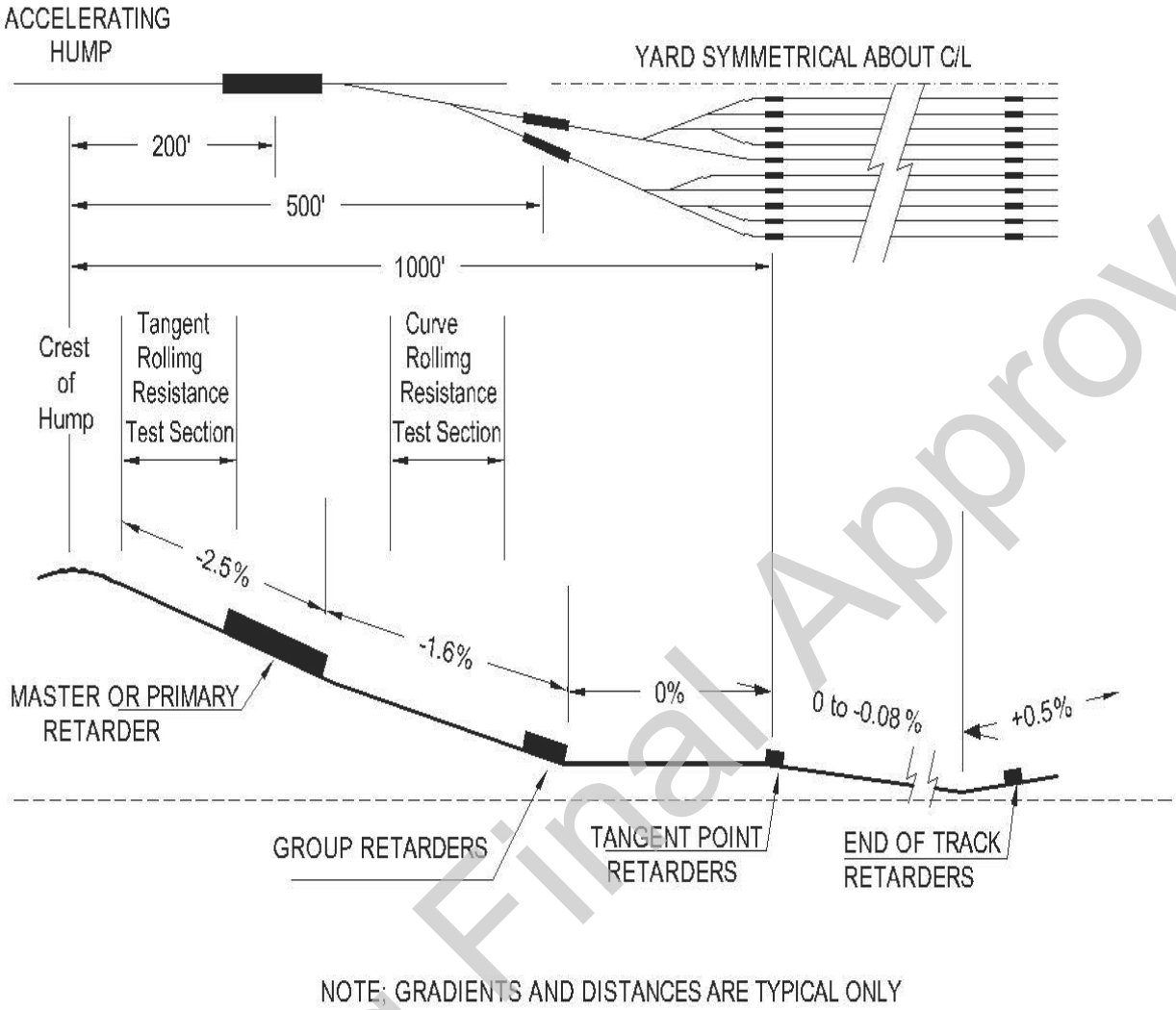



***Figure 14-2-4. Track and Profile Diagram (Intermittent Control)***

e. The quantity of retarders needed for each zone will depend upon the change of velocity required, the maximum car weight and the initial classification track gradient.

f. Typically, the initial classification track gradient can continue for approximately one third of the total track length with retarders installed along the track to prevent the heavy, low rolling resistance cars from accelerating above 4 mph. This initial gradient will assist the penetration of cars down into the tracks and provide a high percentile of coupling.

g. The hydraulic retarders used in continuous control systems are relatively small units installed at close intervals along the tracks. They are fixed to the inside of the running rails and actuated by the wheel flange.

h. Typical gradients associated with this type of yard are illustrated in Figure 14-2-5. In the design of the track profile for a classification yard the gradients will depend upon factors such as car throughput, range of car rolling resistances, track curvature and turnouts, and local weather conditions.

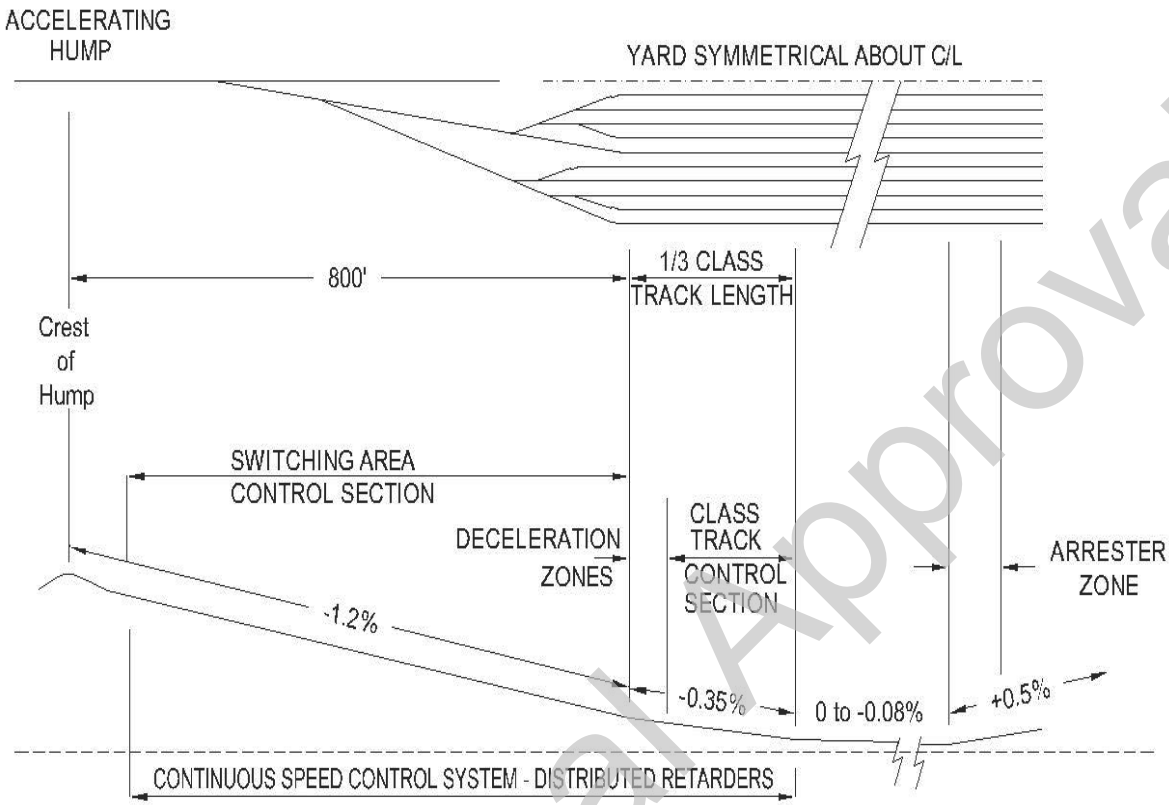



***Figure 14-2-5. Track and Profile Diagram (Continuous Control)***

### 2.4.5.3.3 Hybrid Control System

a. The formulation of a hybrid system of car speed control is based upon the use of the clasp type of retarders, with process controller, in the switching area to perform the duties of maintaining separation and controlling the group retarder exit speeds; and a continuous control system that commences with deceleration zones in the classification tracks and continues with coupling speed control zones.

b. The intermittent control system in the switching area would be as described in Article 2.4.5.3.1.1, Article 2.4.5.3.1.2, Article 2.4.5.3.1.3 and in some cases Article 2.4.5.3.1.4 with a modification to the group retarder exit speed requirements, and the distance to couple circuits would not be needed for speed control. The last active retarder exit velocities would be controlled to provide a bandwidth of velocity for the cars arriving at the deceleration zones, with the lower limit of velocity being applied to the low rolling resistance cars and the higher limit to the high rolling resistance cars in order to ensure good penetration of the light cars through the zone.

### 2.4.5.4 Design Parameters

In preparing for a classification yard design it is necessary to ascertain the parameters.

a. Car throughput, the rate at which cars will be expected to pass over the hump. This can be expressed as the humping velocity. For example 2 mph = 3 - 60' cars per minute.

b. a.The vertical convex and concave curves for the hump profile should be specified in order to ensure adequate clearance from the car structures, prevent binding of car knuckles and insure adequate cut separation.

c. The maximum and minimum car weights should be stipulated in association with car types, length and wheel diameter.

d. Details of the weigh scale length should be ascertained, with the minimum response and record times, in order to be able to specify the minimum time that a car must occupy the scale to produce valid recordings before first point of control.

e. One of the most important parameters is the range of rolling resistance values for the variety of cars to be humped. Detailed research and analysis should be undertaken to determine practical values. A good source of information is the printouts from existing control systems that are already operating in established yards. The basic tangent rolling resistance values for the total car population should be ascertained and specified.

f. In the event of a catch-up between leading and following cars, the movement of the automatic switches is locked in position to prevent derailments. Various types of electrical switch protection circuits can be employed to guard the switches. In order to be able to specify the minimum separation distance between cars it is necessary to ascertain details of the circuits, such as occupation length and response time, along with the response and operating times for the switch machines.

g. Where clasp retarders are used, a retarder of sufficient length should be designed to stop the heaviest good rolling car in the event of an emergency (assuming application of braking throughout the entire retarder). Designing for either primary or group retarders alone to be capable of stopping a car can cater to this requirement. Another option is to design for the primary and group retarders in unison to have sufficient total retardation to stop the heaviest good rolling car (assuming application of braking throughout the entire retarder). The preferred requirement should be specified.

h. The geometric data of curves and turnouts for all tracks will need to be specified for a well-designed yard layout. The layout for curves and turnouts are designed to make the distance from crest to clearance point as short as possible. This will reduce the height of the hump, which reduces the amount of retarders required. The shorter distance also improves yard performance by shortening the time a car is in the switching area and reduces the chance of catch-ups.

i. Additional gradient, to compensate for curve resistance, may be added with advantage to the long curves that lead to the outer groups of tracks.

j. Standard turnouts should be preferred to any of special design as these may not be readily available in a future emergency if a replacement switch panel is needed.

k. End of track retarders in combination with a prevent rollout gradient, should be considered to avoid car run outs. The retarder capacity must be designed to stop a heavy car at a specified maximum velocity.

### 2.4.5.5 Theory

#### 2.4.5.5.1 Car Velocity

a. The velocity of a car traveling along a gradient can be determined at any point by the equation where:

$$V^2 = 2gh$$

where:

V = car velocity, ft/sec

g = gravitational acceleration, i.e. 32.2 ft/sec$^2$

h = energy head, ft

b. The energy head, h can be the potential energy, due to the elevation on a gradient, that will accelerate a car to velocity, V (ignoring resistance losses); or it can be the velocity head, in which case it is the energy invested in the car velocity; for clarity, let H feet = velocity head and h foot = potential head, refer to example Article 2.4.5.5.4.

c. This basic energy equation needs to be modified to include two coefficients that affect the movement of a car, these are:

- The rolling resistance coefficient, R.
- he coefficient k, to allow for the inertia of the wheel sets.

### 2.4.5.5.2 Rolling Resistance

a. The rolling resistance of a car can be expressed as a coefficient, a force per weight ratio or an equivalent percentage gradient, i.e. 0.003 = 6.0 lb/ton = 0.3%. This expression states that a car with a rolling resistance coefficient of 0.003, or 6.0 lb/ton resistive force, would travel with constant velocity on a 0.3% gradient tangent track. The total rolling resistance value for a car is the sum of the tangent rolling resistance + curve and turnout resistance + air and wind resistance.

b. Typical rolling resistance coefficients are:

Tangent rolling restistance = 0.0005 min. to 0.006 max

Curve resistance = 0.0004 to 0.0005/degree

Air/Wind resistance is heavily dependent on car configuration and environmental geometry. Modeling may be used to determine numbers.

**NOTE:** In a Continuous Speed Control system an additional factor must be introduced to allow for the idling resistance of the retarder units when operating below their threshold control speed.

### 2.4.5.5.3 Wheel Inertia

a. The coefficient:

$$k = 1 + (Xwr^2 / WD^2)$$

where:

X = number of axles * 2

w = weight of wheel set, lbs

r = radius of gyration of wheel set, in.

D = wheel tread diameter, in.

W = Car weight, lbs

b. For an estimate of car performance on a given gradient a simplified value for k can be determined from:

$$k = (W + 4000) / W, \text{ for a 4-axle car}$$

c. Typical car weights are 40,000 lbs. to 315,000 lbs.

### 2.4.5.5.4 Change in Velocity

a. To determine change in velocity refer to Figure 14-2-6.

let:

$V_0$, $V_1$ and $V_2$ = velocity, ft/sec

$H_0$, $H_1$ and $H_2$ = velocity head, ft

$h_1$, $h_2$ and $h_3$ = potential head, ft

$D_1$ and $D_2$ = distance, ft

$G_1$ and $G_2$ = gradient coefficient

$R$ = total rolling resistance coefficient

b. To determine $V_1$:

$$V^2{}_1 = (2\ g\ H_1) / k$$

$$H_1 = H_0 + h_1 - (D_1\ R)$$

also $H_0 = 0$ and $h_1 = (D_1 G_1)$

subs. $H_1 = D_1\ (G_1 - R)$

then $V_1 = e\sqrt{[(2\ g\ H_1) / k]}$ ft / sec

c. To determine $V^2{}_2$:

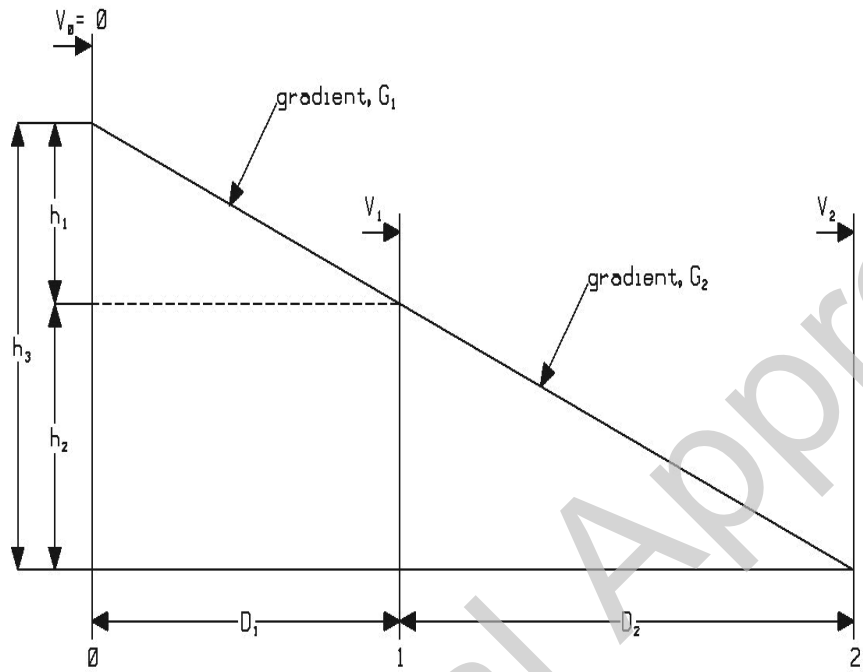
$$V^2{}_2 = (2\ g\ H_2) / k$$

$$H_2 = H_1 + h_2 - (D_2\ R)$$

also $H_1 =$ $_1$ k / 2 g and $h_2 = (D_2\ G_2)$

subs. $H_2 = H_1\ D_2\ (G_2 - R)$

then $V_2 = e\sqrt{[(2\ g\ H_2) / k]}$ ft / sec




Let: $V_0$ , $V_1$ & $V_2$ = velocity, ft /sec.
$H_0$ , $H_1$ & $H_2$ = velocity head, ft.
$h_1$ , $h_2$ & $h_3$ = potential head, ft
$D_1$ & $D_2$ = distance, ft.
$G_1$ & $G_2$ = gradient coefficient
R = total rolling resistance coefficient

***Figure 14-2-6. Change in Velocity***

#### 2.4.5.5.5 Car Separation

The lengths of the Intermittent Control retarders and the weigh scale, and the operation of the switches make it necessary to predetermine the separation of the cars as they travel from the crest of the hump to clearance points in the class tracks.

**NOTE:** In a Continuous Control system only the separation needed to operate the switches has to be considered.

### 2.4.5.6 Time/Distance Curves

a. Each car must be accelerated away from the hump to produce adequate separation distance between cars and this distance must be maintained at a minimum length throughout the switching area. In order to study and analyze the car's performance and separation it is necessary to compute Time/Distance curves and to introduce retardation at critical points in order to adjust speeds and maintain separation.

b. In order to design for a worse case situation it is necessary to take into consideration the separation changes between a light, high rolling resistance car when followed by a heavy, low rolling resistance car, each routed to adjacent class

tracks. There must be adequate separation down to the last level of switches; and finally, a following car must not coincide with a leading one until after the clearance points.

c. For Intermittent Control systems, retarders must be located at the critical points of the Time/Distance curves in order to adjust car speeds and prevent catch-up between cars of varying rolling resistance values. The exit speeds from the last active retarder must be varied to match the distance the cars must run to couple in each class track; when a track is nearly full these exit speeds will be relatively slow and this must be allowed for in the Time/Distance curve by plotting a heavy, low rolling resistance car followed by a light, high rolling resistance car that may need to run un-retarded; refer to the sketch of Time/Distance curves in Figure 14-2-7

d. In Continuous Control systems the car velocity, after initial acceleration, will be nearly constant with little change in separation; it is however, necessary to allow for a speed control bandwidth due the variation in wheel diameters; refer to the sketch of Time/Curves in Figure 14-2-8..

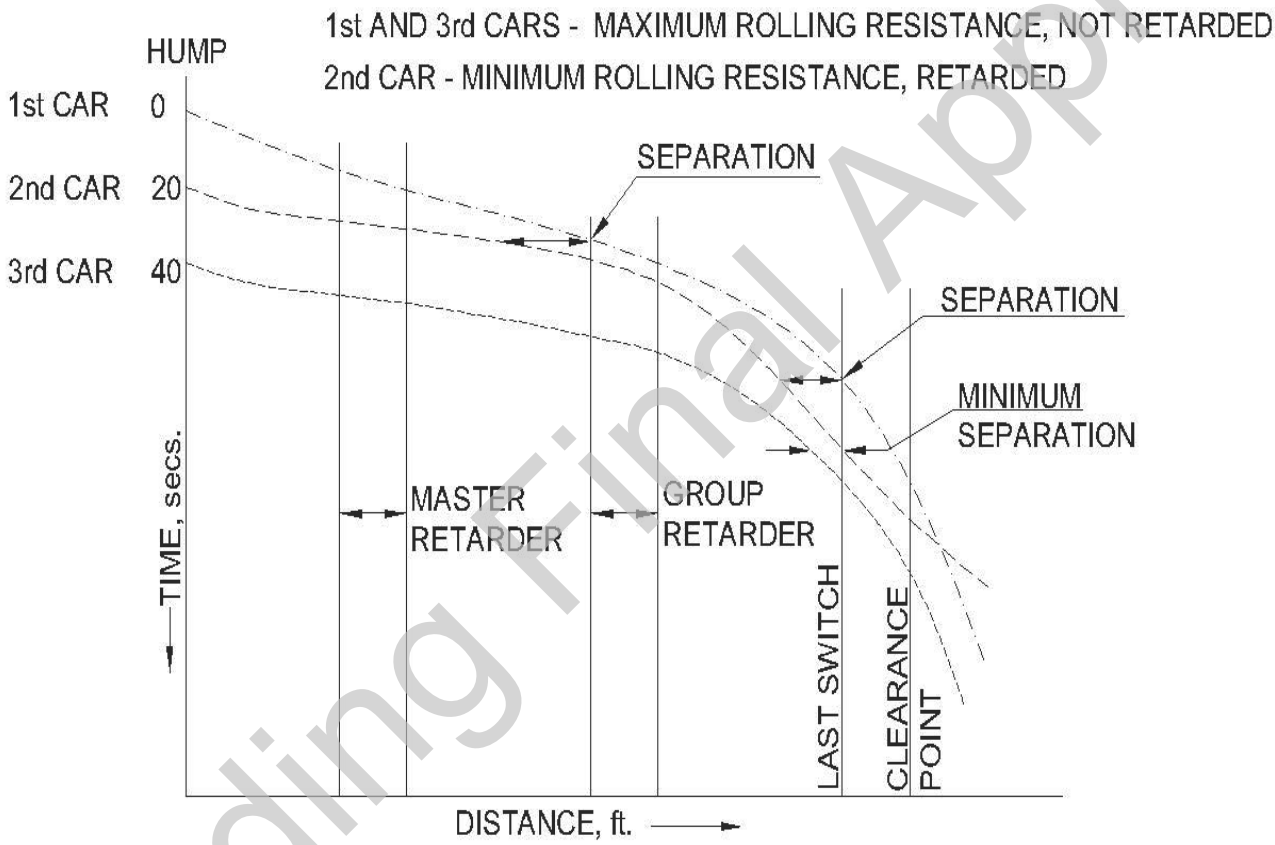



*Figure 14-2-7. Sketch of Time vs. Distance Curves (Intermittent Control)*

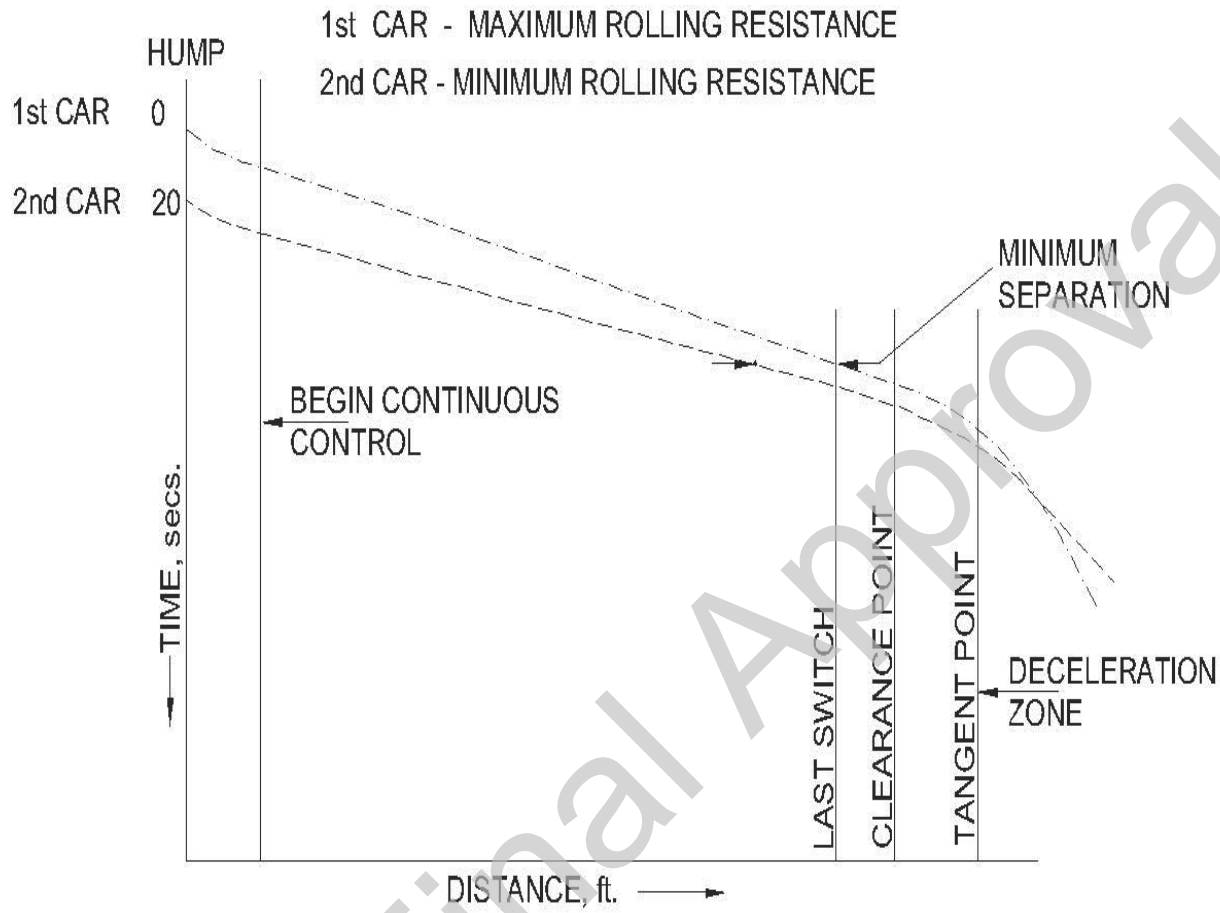



***Figure 14-2-8. Sketch of Time vs. Distance Curves (Continuous Control)***

### 2.4.5.7 Retardation

a. A typical intermittent retarder yard will comprise a primary retarder and a number of group retarders: the primary will be situated near the hump and its function is to adjust speeds for separation control. The groups, located at the end of the switching area gradient, control the speeds of cars entering the class tracks; their prime function is to release cars at predicted speeds in order to achieve 4.0 mph coupling at varying distances down the tracks. This method of operation is often referred to as target shooting and employs Distance to Couple circuits in the tracks, combined with computed exit velocities from the groups. If tangent point retarders are used at the entrance to the tracks, then the groups will target shoot to these and the tangent point retarders will then control the final distances and coupling speeds.

b. In a Continuous Speed Control system the retarder units are installed at regular intervals throughout the switching area and for distances down into the class tracks. The quantities of retarders needed to provide speed control are dependent upon the control velocity, and are directly proportional to the effective gradient (gradient minus total rolling resistances) and the maximum car weight.

$$\text{Retarder density} = A(G - R_{min}) / E, \text{ units / ft}$$

where:

A = Maximum axle load, ton
G = Gradient coefficient
$R_{min}$ = Minimum total rolling resistance coefficient
E = Retarder energy, ft ton / unit at specified control velocity

c. At the tangent points the retarders are installed in dense banks, forming deceleration zones to slow the cars from the switching area velocity down to a 4.0 mph coupling speed.

$$\text{Quantity of retarders/zone} = A(V^2_S - {}^2_C)k / (2gE)$$

where:

$V_{SA}$ = Switching area velocity, ft/sec
$V_{CV}$ = Allowable coupling velocity, ft/sec

d. As a slight accelerating gradient is usually extended down into the class tracks it is necessary, in order to maintain a coupling speed of 4.0 mph maximum, to continue with a speed control section comprising an appropriate quantity of retarder units. The retarder density can be determined by applying the formula used above to calculate unit density in the switching area.

#### 2.4.5.7.1 References

References used in this Part are located at the end of this chapter. See Reference 1, 2, 3, 4 and 5.

## SECTION 2.5 FLAT CLASSIFICATION YARD DESIGN

### 2.5.1 GENERAL (2010)

#### 2.5.1.1 Objective

The ideal objective is the design of a series of gradients so that each car will roll to and stop at the far end of the classification yard, or will roll to coupling at an acceptable speed. The following objectives are the minimum to be expected.

a. Deliver cars having a practical maximum rolling resistance to the clearance point under adverse weather conditions.

b. Deliver cars of the most frequently-occurring rolling resistance to the far end of the yard, or to some desired intermediate point, if the block sizes do not require filling the track.

c. Permit maximum switching rate and acceptable coupling speeds.

#### 2.5.1.2 Rolling Resistance

The designer must be familiar with car rollability and the factors which can contribute to rolling resistance. See Article 2.4.5.4, Design Parameters and Article 2.4.5.5, Theory (including car velocity, Rolling Resistance, Rotational Kinetic energy, and velocity formulas).

#### 2.5.1.3 Commodities and Equipment

The design should reflect the type of equipment to be used and the commodities to be handled.

### 2.5.2 GRADIENTS (2010)

The following data are presented to assist in the design of a flat yard with optimum gradients for the switching of cars. The various segments of a flat yard with letter designations are shown in Figure 14-2-9.

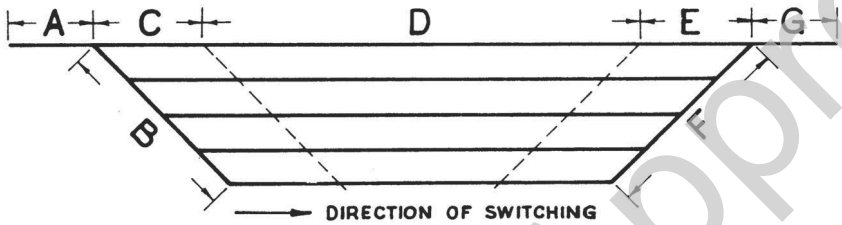



*Figure 14-2-9. Flat Yard for Single-Direction Switching*

#### 2.5.2.1 Segment A & G: Switching Lead or Drill Track

Gradient here is not critical. Cars are normally released on or close to the ladder (segment B). However, since this segment accommodates constant bi-directional movement, the gradient should be relatively flat, with 0.00% preferred.

#### 2.5.2.2 Segment B and C: Ladder and Switch to the Clearance Point

The preferred gradient is "slightly" accelerating; which means that the grade must descend sufficiently to overcome rolling, switch and curve resistances. The preferred gradients for these segments range from -0.20% to -0.30%. In special cases, gradient on the ladder can be level if cars are to be released near the switch of their classification track.

#### 2.5.2.3 Segment D: Clearance Point to Clearance Point

The preferred design gradient for this segment is "slightly" decelerating ranging from -0.10 to 0.00%.

#### 2.5.2.4 Segments E, F and C: Leaving End of the Yard

a. Segments E and F should have sufficient adverse (uphill) gradient to prevent rollouts and thus minimize the need for retarders or skates. Approximately 300 feet of 0.3% grade is suggested.

b. When conditions permit it is highly desirable to design a flat yard for switching at both ends even when current operations might not require double-ended switching. A flat yard for double-ended switching would have gradients in segments G, F and E the same as those in segments A, B and C respectively, and gradient in segment D would be either level or "slightly" descending from each end toward the middle. The yard profile would resemble a saucer.

c. In a flat-yard drilling operation, the car, when it is uncoupled, is not unlike the car leaving the group retarder in a hump yard in that each car has just departed from its last point of external control, unless the ladder leads tracks are equipped with one of the multi-unit distributive type of the retarder systems as discussed in section 2.5.4. Hence, the basic formula for the hump yard from the group retarder to the clearance point could be applied to the flat-yard design as follows:

Drop from uncoupling point to clearance point = $SR_e$, + $\gamma C$ +

NSW + a where:

S = Distance in feet (meters)

$R_e$ = Rolling Resistance of easy-rolling car expressed decimally

$\gamma$ = Curvature in degrees of central angle

C = Curve resistance in feet (meters) of drop per degree of central angle

SW = Switch resistance in feet - 0.06 foot per turnout (0.0183 meters per turnout)

N = Number of switches

a = Difference in velocity head at clearance and velocity head at uncoupling point for easy-rolling cars.

**NOTE:** If metric units are used for any items, they should be used for all items in the formula.

d. The gradients in the body tracks must not produce unacceptable acceleration of easy-rolling cars.

## 2.5.3 DESIGN FACTORS (2010)

### 2.5.3.1 Yard Configuration

a. If possible, a track should be designated for each classification to be made. However, it should be remembered that a flat yard is best suited to a situation where the number of switching cuts is small. While fairly large volumes of cars can be handled in a flat yard, a large number of cuts reduce its effectiveness.

b. Body tracks should preferably be on a tangent and of sufficient capacity to hold the volumes of each classification under normal circumstances.

c. Ladders should be designed to minimize distance to clearance point and provide maximum yard capacity. Switches should be as close together as possible for efficient handthrowing. Multiple-frog-angle ladders allow the designer to provide a compact layout; however, when hand-throw switches are used, the layout should be such that all switch stands are on the outside of the ladder. Inside switch stands should be used only when power switching is provided.

### 2.5.3.2 Drainage

a. The flat yard will have a natural tendency to retain water, since its profile will usually take the shape of a saucer. Good drainage is imperative to maintain designed track grade, alignment and structure. In most cases, a subsurface drainage system will be required, unless the subgrade is very porous.

b. The grades of segments B and C in Figure 14-2-9 are between -0.2 and -0.3%. As more tracks are added to the design, the drop in elevation to the outside tracks increases. This drop may require an extension of the grade further into the body tracks of the first tracks on the lead than is desired (segment C). If that is the case, then consideration should be given to lowering the elevation of each track from 0.4 to 0.5 foot which would drain the yard to the outside of the classification tracks. The yard would drain with equalizer pipes put through the grade at the lowest elevation.

## 2.5.4 LADDER TRACK YARDS WITH CAR SPEED CONTROL (2010)

### 2.5.4.1 Introduction

When designing, what has traditionally been known as a flat yard, it is not possible to select a gradient for the ladder lead tracks that is compatible with the rolling resistance values of all cars. If the gradient selected is suitable for the average

rollability car, then those with a low rolling resistance coefficient will accelerate to unacceptable speeds and conversely, those with a high rolling resistance coefficient may stall on the track before reaching their switch destination.

### 2.5.4.2 Car Speed Control on Ladder Lead Tracks

A method of overcoming this problem is to introduce the multi-unit type of hydraulic retarders and distribute them throughout the length of ladder lead tracks to provide continuous car speed control. It is then possible to select a gradient that has sufficient inclination to ensure that the high rolling resistance coefficient cars will reach the farthest clearance point in the classification tracks, but at the same time, the retarders will control the acceleration of the low rolling resistance coefficient cars and limit their velocity to a predetermined maximum.

For yards constructed in warm and temperate climates, typical ladder track gradients can be in the order of 0.4% to 0.45%; and for locations where low temperature conditions are experienced typical gradients can be 0.5% to 0.75%. If possible, the lengths of the ladder tracks should be restricted to around 1,000 feet from the king switch[1] to the last switch to minimize the number of stalled cars during inclement weather conditions. These typical parameters are based upon a car velocity of approximately 6.0 mph; if higher speeds are selected then the gradients could be less, or the length of the ladder lead tracks extended; if lower speeds are chosen then the inverse applies. The use of tandem turnouts can limit the length of the ladder lead tracks and provide for about 32 classification tracks.

### 2.5.4.3 The Addition of a Mini-Hump

The efficiency of the switching operation can be enhanced by constructing a mini-hump on the switching lead track. This hump would assist the uncoupling procedure and enable a continuous humping process, replacing the normal flat yard 'drilling' method of operation. A hump profile of around 200 feet x 1.0% could be used to accelerate all cars to 6.0 mph retarder control velocity on the ladder tracks; if higher speeds are required, then the hump elevation can be increased to give additional potential head. A number of retarders would be needed on the hump to control the acceleration of the minimum rolling resistance cars.

### 2.5.4.4 Additional Coupling Speed Control

If a maximum allowable coupling speed is an operational requirement in the classification tracks, then this can be achieved by extending the retarder system to include these tracks. Retarders can be located at the tangent points to decelerate the cars to the specified coupling speed. To further enhance both the coupling speed control and the car penetration down the classification tracks, suitable gradients can be constructed with retarders distributed along the tracks to form continuous speed control sections. There are many combinations of track gradients and length of speed control sections that can be employed; the final solution would be dependent upon the degree of coupling speed control that is specified.

### 2.5.4.5 Diagram 1

A Ladder Track Yard with Car Speed Control is illustrated in Diagram 1. All values are typical only, but the plan and profiles are based upon an actual design for a yard located in a warm climate area; the parameters for that design included:

a. Maximum car weight = 270,000 lbs.

b. Range of Rolling Resistances = 2 lbs/ton minimum to 8 lbs/ton maximum

c. Coupling speeds = 4 mph average & 6 mph maximum

[1] The colloquial term designated to represent the first or primary switch, usually located near the crest of an automated switching yard, from which all other lead switches originate.

A mini-hump was added to enhance the switching operation and to accelerate the cars to 6 mph at the King Switch. The 650 feet x 0.25% gradient in the classification tracks was included to assist car penetration and the 400 feet x 0.35% reverse gradient was constructed at the trim end to prevent car run-out.

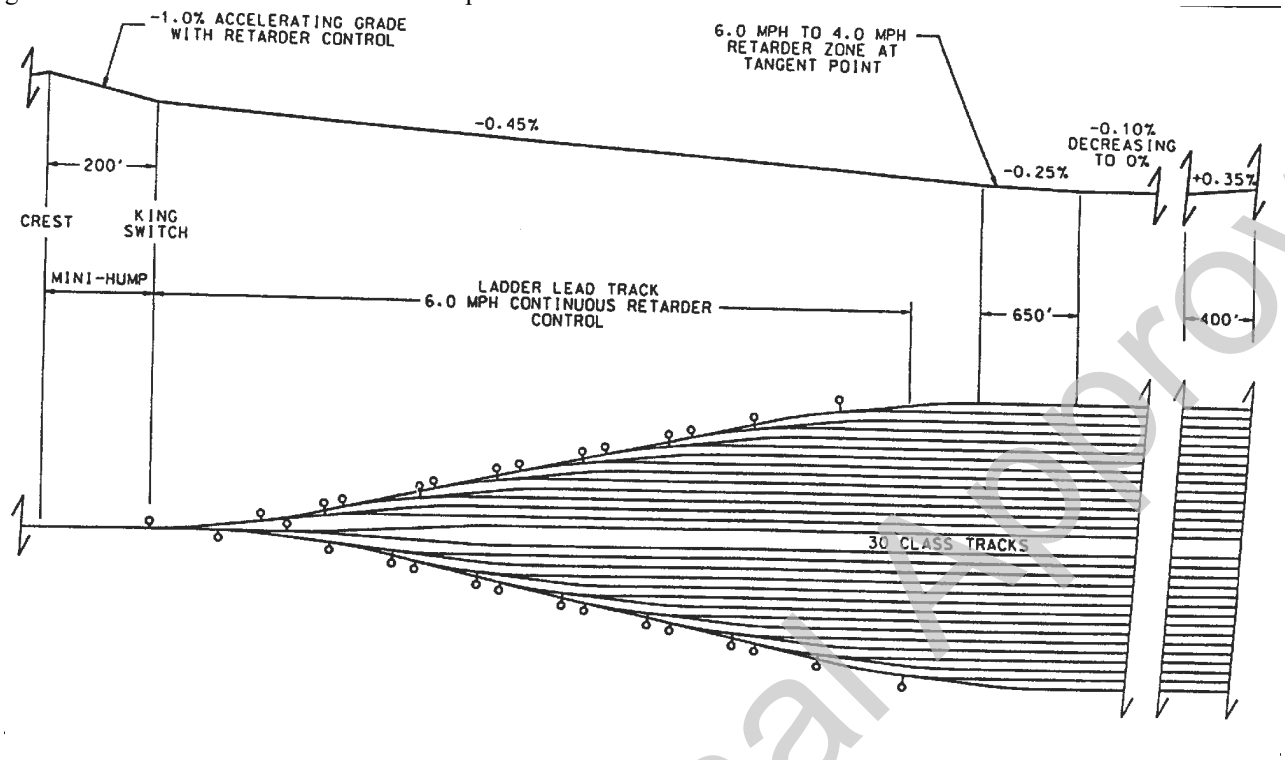



***Figure 14-2-10. Typical Track Diagram and Gradient Profile Ladder Track Yard with Car Speed Control***

## SECTION 2.6 TERMINAL DESIGN CONSIDERATIONS FOR RUN THROUGH TRAINS

### 2.6.1 CHARACTERISTICS OF RUN THROUGH TRAINS (1993) R(2016)

Run through train operations involve the handling of service from the train origin to train destination with bypass of normal intermediate yard humping or reclassification. Many variations of the definition for a run through train exist in current rail operations. "Pure" run through trains operate from the shipping origin as a protected "unit" to the receiving destination on a loaded cycle. Many times the train is assigned as a dedicated train set and cycles from origin to destinations. Variations in train operations for unit run through trains include:

- Single Origin - Various Local Destinations.
- Various Local Origins - Single Destination.
- Various Local Origins - Line Haul - Various Local Destinations.

### 2.6.2 RUN THROUGH TRAIN OPERATION (1993) R(2016)

The operation of these trains in a terminal will likely have an impact on the support yards' efficiency, depending on the required handling of the particular run through trains. In addition, the handling of these trains likely will impact main track

operations in and around the terminal. It is important, therefore, that as terminals are laid out or reconfigured that consideration be given to minimizing the impact on yard and main track operations.

## 2.6.3 YARD FACILITY FUNCTIONS (1993) R(2016)

The primary functions involved in the handling of the bypass or run through trains at a yard facility are crew change, power change, train changes, train inspection and train servicing.

### 2.6.3.1 Crew Change

Terminals are likely locations where run through trains change crews. The timing of these changes will be affected by the amount of work to be done with the run through train in the terminal.

### 2.6.3.2 Power Change

Generally, run through train power consists are handled without change at intermediate terminals. Exceptions to this would be power requiring change due to failure on line of road or power change necessary to handle route alignment or train tonnage alteration. Power requirements for the departure trip route is governed by increase or decrease in ruling grades.

### 2.6.3.3 Train Changes

Generally run through trains are handled as a unit from origin to destination. Exceptions to this would be short unit trains such as grain trains that will be filled with additional blocks at intermediate terminals. Other conditions affecting train changes would be ruling grade restrictions requiring reduction and filling of the train on either side of the grade. In these cases, set-out and pickup tracks should be made available adjacent to tracks occupied by the run through train.

### 2.6.3.4 Train Inspection

Inspection of run through trains may be necessary at the terminal depending on where the train originated or other FRA and local requirements. This is accomplished through a vehicle or walking inspection as necessary.

### 2.6.3.5 Train Servicing

Run through train power may be serviced intact. Those that are may have fuel, sand and water added as well as supplies for the locomotive. The end of train device (ETD) may also be serviced.

## 2.6.4 DESIGN OBJECTIVES (1993) R(2016)

### 2.6.4.1 Access to Main Lines

Where run through trains are routed or held on other than main tracks, those bypass tracks should be adjacent to the main line. Turnouts should be designed to provide entrance and exit to these tracks at 25 to 30 MPH to minimize train delay. Power or spring switches should be considered at these locations.

### 2.6.4.2 Access to Main Yard

Consideration should be given to the proximity of where the run through trains are routed or held to the main yard. Cars for pickup or set-out for the run through trains will likely travel through the main yard or nearby support yards. Movement to and from these yards should cause minimal impact to the main line operation.

#### 2.6.4.3 Access to Crew Office

Crew change locations for run through trains should be close to crew facilities to minimize delays. Consideration should be given to roadway access at these locations to minimize trains blocking crew vehicles and provide easy turnaround.

#### 2.6.4.4 Access to Locomotive Shop

Track layout should provide direct access to the locomotive shop, where applicable, for power change-out on run through trains. Route should minimize delays due to yard or main track movements.

#### 2.6.4.5 Access to Car Shop

Consideration should be given to the proximity of the Car Maintenance facility. Bad order cars on run through trains will require placement and pickup for the nearest car shop. Train inspection personnel may likely be headquartered at the maintenance facility as well.

#### 2.6.4.6 Train Inspection

Inspection roads and access should be provided to allow for both rolling and walking inspection of the through train. Inspection access should provide the ability to perform light repairs to the intact train if the repair condition can be handled without switching.

#### 2.6.4.7 Train Servicing

Train servicing facilities generally include access for power consist fueling and spot maintenance. The run through handling of unit trains may require power or car setoffs. Consideration should be given to allow for switching tracks at both ends of the holding tracks assigned for run through trains. Also servicing of end of train devices (ETD) and protection of employees including that required by "Blue Flag" rules should be considered.

### 2.6.5 DESIGN FEATURES (1995) R(2016) See Figure 14-2-11 and Figure 14-2-12.

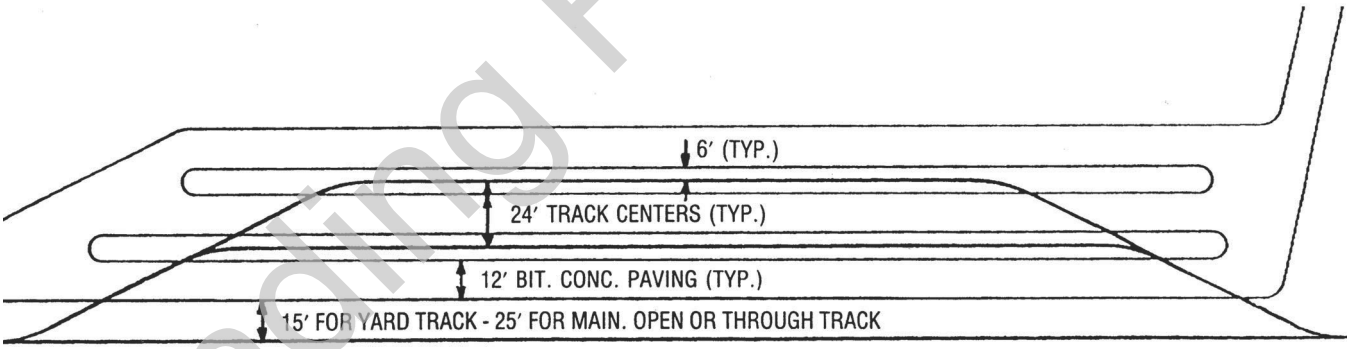
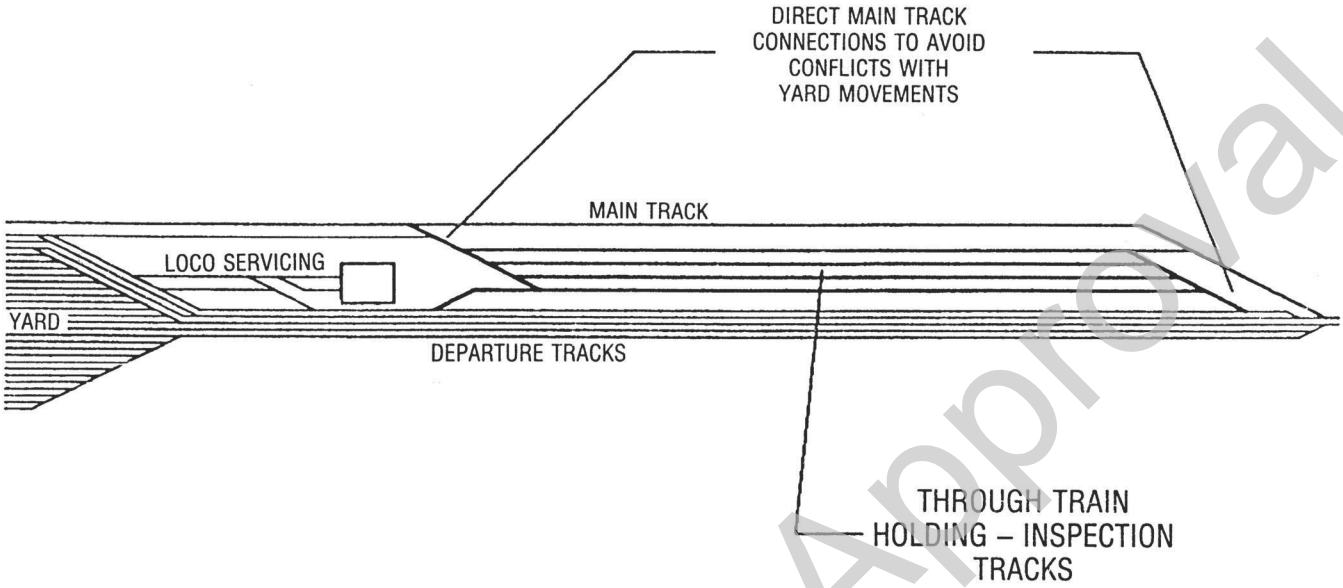


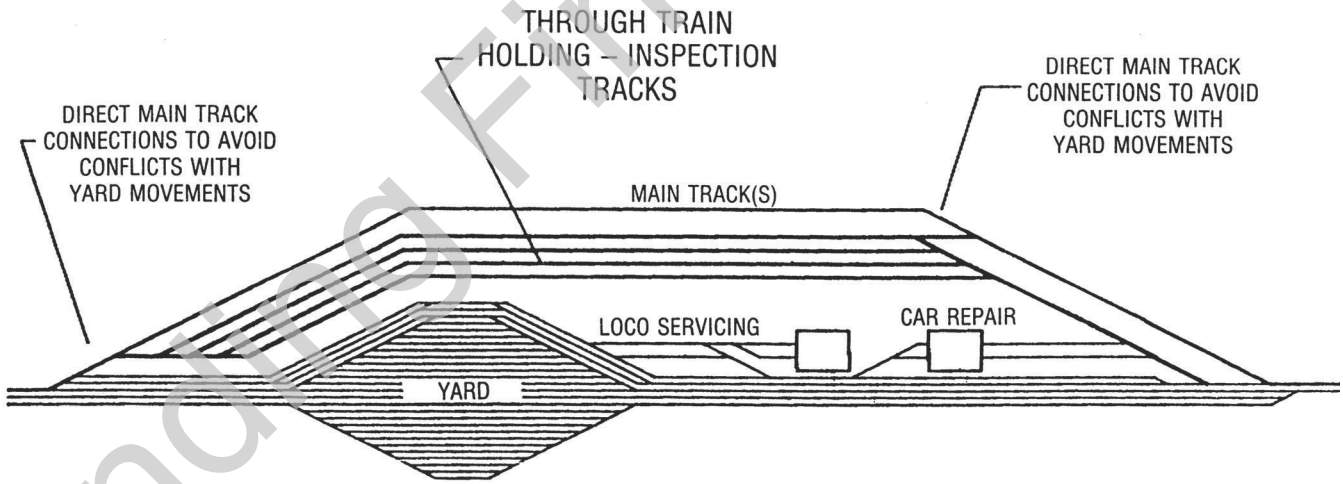

***Figure 14-2-11. Through Train Track Layout***

#### 2.6.5.1 Bypass Yard and Siding Tracks

These tracks should be designed to handle the maximum train length. They should be accessed through standard lead ladders with turnouts sized to permit 25 to 30 MPH speeds. The rail in these tracks should be sized to permit these track speeds as well. Where expected train volume would warrant power or spring switches they should be considered.




**VIEW A**




**VIEW B**

***Figure 14-2-12. Example Layout***

#### 2.6.5.2 Engine Tracks

Consideration should be given to providing trackage for temporary locomotive storage. This trackage could be utilized to stage locomotive changeouts or for fueling and servicing locomotives. It should be in close proximity to the bypass yard.

#### 2.6.5.3 Fueling and Servicing

The requirements should be considered for run through train power. A fueling station on the engine track may be necessary to provide quick access to fuel and light engine service, including locomotive supplies. It may be feasible to fuel and service at the locomotive shop or by a mobile truck. For any of these options, ease of access, proper fueling equipment, environmental protection and protection of employees working on engines should be considered.

#### 2.6.5.4 Yard Air

Yard air may be required on the bypass tracks for expediting train movement. A review should be made of the type of car set-outs and pickups and the duration these train blocks will be required to await movement.

#### 2.6.5.5 Roadways

Roads should be built to provide access to crew change locations, inspection along bypass yard tracks and easy access to other terminal facilities. They should be preferably hard surfaced, low maintenance roads and include the necessary clearances and signage around crossings and adjacent to tracks for safe vehicle movement.

#### 2.6.5.6 Lighting

Adequate lighting should be considered for bypass yard leads, crew change points, engine tracks or other locations where regular activity will occur.

## SECTION 2.7 YARD DESIGN FOR REMOTE CONTROL LOCOMOTIVES (RCL)

### 2.7.1 CHARACTERISTICS OF REMOTE CONTROL LOCOMOTIVES (2007)

Remote control locomotives (RCL) are used by Class 1, 2, and 3 railroads and by many industries. The use of RCL equipment places the operator near the point of coupling and uncoupling which reduces the chances of lading damage, and also reduces manpower required in yard operations. RCL equipment is operated by a radio control unit carried by the operator or at a fixed control location, and can only be used on locomotives or locomotive consists equipped with a radio receiving unit matching the frequency of the operator's control unit. The control unit usually features forward and reverse, throttle, and braking controls, plus sand, headlights, and horn. In some industrial applications, a remote control uncoupler mechanism is installed on one or both ends of the locomotive. The control units also incorporate a trip stop feature to immediately stop the RCL unit if the operator trips or falls. The locomotives may or may not be equipped with indicator or strobe lights on the side or top of the unit to indicate when RCL is in use, and direction of travel.

### 2.7.2 GENERAL YARD DESIGN OR REDESIGN (2007)

New yards may be designed for RCL equipment, but many existing yards have been or will be converted to RCL use. These existing yards may not be ideally configured for RCL use, but the following guidelines may be used to modify an existing yard to the extent practical for RCL use. Remote control switches are part of potential yard design or redesign issues.

#### 2.7.2.1 Lead Tracks

Yard leads or "pullback tracks" should be as long as the longest yard track, or as long as the longest cut (block) of cars to be handled plus the length of the power consist plus safe stopping distance. A slight curve toward the direction of the yard's ladder tracks will aid an operator standing along the ladder switches to view the position of the far end of the locomotive and cut of cars. In any case the operator must be able to judge the position of the far end of the cut in relation to the end of the lead or pullback track. Positive stop equipment may be installed on track and locomotives to provide more security against exceeding travel limits by automatically halting the locomotives and cars approaching the limit of travel. Additionally, remote control switches should have a clearly visible indication system to allow the operator to see switch positions from a distance.

#### 2.7.2.2 Radio Reception

RCL units depend upon line of sight radio communication. Potential obstacles to radio communication should be removed. If a radio communication analysis or survey reveals obstacles to radio transmission that cannot be removed, a repeater unit should be provided to eliminate loss of radio communication between the operator's control unit and the locomotive. The repeater unit should be mounted as high as practical to gain maximum range for the signal.

Similarly, voice radio communications between the yard crew and other yard operations is essential for safety of RCL operations, and repeaters should be positioned for voice radios as well according to the communications survey. Note that yard crews that formerly depended on the locomotive radio for voice communications will now have to rely solely on their portable units.

#### 2.7.2.3 Ladder Tracks

Ladder track turnout areas should be free of trip and stumbling hazards, and should be laid out so that the pullback track or tracks are visible from the ladder switch area. RCL operators should not be required to stoop to throw switches to eliminate inadvertent activation of the "tilt stop" feature of the control unit. Power-operated or power-assisted push-button switches in the ladder tracks are recommended. Indicator lights or other devices to indicate switch point position from a distance are suggested to aid operators who may be some distance from the switch while operating. In areas where snow inhibits switch operation, switch heaters or blowers are suggested to enhance yard operations during snow conditions.

#### 2.7.2.4 Track Centers

It is essential that operators on the ground be able to see and judge car or engine position during coupling and switch moves, and to be able to freely move between ladder tracks when coupling or uncoupling cars. Therefore, ladder tracks should have wider centers to allow this visibility and to minimize exposure of the operator to being struck by loose banding or shifted loads.

### 2.7.3 ISOLATION OF RCL OPERATIONS (2007)

Since some RCL equipment differs in operational safety procedures from regular switching operations, the trackage where unoccupied RCL equipment operates is required to be separated from other railroad operations. RCL equipment must be able to operate without point protection (crewmember on or observing movement of the lead car in the direction of movement) without concern for other conflicting yard movements. The following requirements apply.

#### 2.7.3.1 Signage

Warning signs must be posted at all entry points where RCL operations may occur. These signs should be placed at known roadway entry points, at locations where trespassers are known to enter the yard, and where unoccupied locomotives operate at or near sidewalks and roadways parallel to the RCL zone location. At times when RCL operations are underway, additional signage must be applied to warn railroad personnel and others that RCL equipment is in operation. Signage should be placed at all locations where track entry points occur into the RCL zone to warn train crews of RCL operations. In particular, signage

should be placed at every point a non-pullback track enters the remote control zone of operation, whether facing or trailing movements. Care must be observed to avoid creation of close clearances when placing the signage.

#### 2.7.3.2 Grade Crossings

In general, grade crossings should be avoided where RCL operations are contemplated. Where crossings are unavoidable RCL operations proposed over grade crossings should take into consideration how movements over the crossing will be observed by the RCL operator. Crossings utilized by yard or plant operating and maintenance crews should be marked with additional signs to advise that RCL equipment may be in use. Cameras and monitors could be employed to provide operators with a view of the crossing.

#### 2.7.3.3 Signaled Trackage

Unoccupied RCL operations are not allowed within the limits of interlocking plants, signaled trackage, or controlled trackage without proper authority. All trackage within the zone of RCL operation must be under the sole control of the RCL foreman or operator that occupies the zone of RCL operation.

### 2.7.4 LIGHTING (2007)

Lighting along pullback tracks and along ladder areas should be similar to that for other lead tracks or hump tracks. Good lighting is necessary for the operators to see the ends of cuts of cars or the locomotive and to help prevent trips, slips or falls along the lead and ladder tracks. The guidelines set forth in Chapter 33, Part 10 should be followed for the applicable areas in RCL yards.

### 2.7.5 WALKWAYS (2007)

Care should be taken to provide an unobstructed walking surface for RCL operators. Ballast for leads, ladder areas, and walkways along ladder tracks should be AREMA size 57 or similar yard ballast for good footing and drainage.

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# Part 3

# Freight Delivery and Transfer[1]

## — 2017 —

### FOREWORD

Railroads historically have had freight houses in terminal locations to accommodate the delivery and transfer of freight, handling of less-than-car-load (LCL) business, and freight consolidation. Team tracks were often provided in the terminal areas as well to facilitate the rail customer's use in loading and unloading freight. Business practices and operations have changed and these facilities have been largely replaced by the intermodal transportation network and specialized freight terminals.

It is anticipated that as the LCL business evolves it will become disconnected from the railroads' direct operations and facilities and will be provided through a third party logistics company or other consolidators of freight. It is recommended that the shipper of LCL freight consult with the railroads to ensure that the freight can be handled in accordance with the railroads' current practices.



[1] References, Vol. 77, 1976, p. 87; Vol. 83, 1982, p. 363; Vol. 91, 1990, p. 107.

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# Part 4

# Specialized Freight Terminals[1]

## — 2019 —

### FOREWORD

This part deals with the engineering and economic problems of location, design, construction and operation of freight terminals for the expeditious handling of a single type commodity or merchandise as opposed to the handling of several types of commodity or merchandise as in Part 3, Freight Delivery and Transfer.

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[1] References, Vol. 77, 1976, p. 87; Vol. 83, 1982, p. 363; Vol. 85, 1984, p. 157; Vol. 88, 1987, p. 86; Vol. 90, 1989, p. 91; Vol. 91, 1990, p. 107; Vol 94, p. 109; Vol. 97, p 157.

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## SECTION 4.1 RAIL/WATER TRANSFER FACILITIES

### 4.1.1 GENERAL

Rail/water transfer facilities provide for the transfer of shipments or cargoes from ship or barge to railroad cars or trucks, and from railroad cars or trucks to ships or barges. The facilities at a terminal typically consist of docks with loading and unloading equipment, suited for general or specific commodities, railroad tracks and roadways, and support buildings and equipment for transfer purposes.

In designing rail/water transfer facilities, consideration must be given to the type and quantity of freight to be handled. Some facilities may be designed purely for the transfer of commodities to other modes or directly to a customer, whereas other facilities may provide intermediate storage between modes, or storage on behalf of the customer. Individual customers may be served at a terminal or multiple customers may share the terminal and its facilities.

One or more different commodities may also be handled in the same terminal. Some docks and facilities may be designed to specialize in the handling of a single commodity, such as ores, coal, grains, fruit, automobiles or other vehicles, and general merchandise.

### 4.1.2 SITE SELECTION

The site for the terminal should be selected to accommodate both near and long term development of the facility to handle the volumes of traffic projected for each commodity. Ease of access for customers and all modes of transportation involved are critical in selecting a suitable site. Site selection and configuration should allow for economy in movement of materials, unloading and loading equipment, and transportation equipment.

The following factors should be considered during selection, planning and construction of the site.

#### 4.1.2.1 Environment

Various chapters of the Manual discuss environmental considerations in detail. Environmental items which typically impact facility design that should be considered include:

a. Air pollution (vapor and dust control and collection)

b. Water pollution (rainfall runoff, spill containment, treatment facilities)

c. Spill containment (for liquids and solids)

d. Noise levels (impact on terminal employees and surrounding areas)

e. Light pollution (from terminal lighting, vehicles, equipment)

f. Proximity to archaeological and historical sites

g. Proximity to residential areas

h. Proximity to ecologically sensitive areas including wetlands

i. Elevation of facility relative to ocean tides and storm surges, or stream flood stages

#### 4.1.2.2 Size

The site selected for a terminal and its facilities should have sufficient land area to allow for future expansion and development. Sizing of equipment and structures should also allow for expansion and flexibility of operation.

The duration of time allocated to load and unload vessels, railroad cars, trucks and storage areas, and the frequency of transportation services, will impact the sizing of various elements of a terminal.

#### 4.1.2.3 Access

##### 4.1.2.3.1 Roads

Highways, streets and other roads to be used for access must provide an efficient route for customers. Routes to the site should be carefully studied for their ability to accommodate trucks and equipment that will serve the terminal. Weight restrictions including seasonal restrictions, pavement width, curves, intersections and existing traffic volumes and patterns should all be considered relative to the size and type of trucks and equipment that will use them.

Routes for trucks serving the terminal should also be carefully studied to determine whether they will pass or be near schools, hospitals, parks, community centers, residential areas, and other sensitive areas. Local ordinances may exist that prohibit truck traffic on certain roads. Also, site selection should consider public opposition that may prevent new or additional traffic on certain roads.

Site access for emergency vehicles should also be considered, incorporating specific access roads or gates into the site plan as necessary for use by emergency vehicles only.

##### 4.1.2.3.2 Waterways

The terminal may be located at waterside of an ocean, an estuary, or a lake or river, but is usually on a harbor of one of these. The site for a rail/water transfer terminal should be on a regular water shipping route accessible to vessels of the type and draft that carry the commodities to be handled, and where necessary maritime services, such as pilots and tug boats, are available to the water carrier.

Water access should provide sufficient draft, maneuvering and turning basins, and berthing space for the size and type of vessels to serve the terminal.

Seasonal restrictions to certain waterways in northern climate should also be considered in designing storage facilities.

##### 4.1.2.3.3 Rail

Rail access should be designed to efficiently accommodate rail traffic serving the terminal's customers. The length of cars, locomotives and trains, frequency of switching movements, serving the terminal, and the characteristics of existing mainline train movements and other operations, should be considered.

The site should be accessible to rail switching from a line which is free of clearance restrictions for the size (length and height) railroad cars and other equipment expected to serve the terminal. The sharpness or degree of curvature of the track (including turnouts) should be considered as well so as to not restrict the use of rail equipment. The line's capacity should also be carefully studied and considered to provide for short-term service needs and allow for future growth.

Modification of an existing yard may permit utilization of little used assets and use to advantage a site with good access. In other instances, selection of an active, new or undeveloped location may be prudent.

#### 4.1.2.4 Utilities

Utilities required for the site should be considered during the site selection process. Water will be necessary for fire protection, employee washdown (i.e., showers, eye washout), dust control, equipment cleaning and employee facilities, along with sewage disposal. Electrical power and/or natural gas will be needed for commodity handling equipment, lighting, heating/cooling/ventilation equipment and other equipment. Telecommunications lines will also be needed for voice and data transmissions for within the terminal and to the outside.

A backup power system for the terminal may also be desirable, particularly for security, telecommunications, fire protection, and other critical systems requiring power during primary system outages.

#### 4.1.2.5 Zoning and Permitting

Many government agencies have enacted laws which may impact the selection and construction of waterfront terminals and facilities. Proposals to locate this type of terminal in areas not properly zoned or near residential, commercial, or recreational areas including schools and hospitals are frequently controversial to the public. Public hearings and other legal processes frequently become necessary when a controversial site is selected.

Permits of some description are required at nearly all locations.

Schedules for placing a terminal in-service should consider the time associated with such hearings and legal processes and obtaining permits. In situations in which the timely completion of a terminal is critical, it may be prudent to select a site that will minimize controversy.

### 4.1.3 GENERAL DESIGN

#### 4.1.3.1 Marine Docks

A dock is a marine structure at which ships or barges are moored. It may consist of a series of breasting and mooring dolphins with a structure for the shiploader/unloader, a dock with a rail mounted traveling shiploader/unloader, or an intermediate type. A dock constructed parallel to the shoreline is typically called a "wharf", while a dock constructed at an angle, ranging from acute to right to the shoreline, is called a "pier". Wharves and piers may be open or covered, depending on the protection needed for the commodity handled.

Wharves may be served by tracks located parallel to the wharf adjacent to the water's edge to allow goods to be handled directly between ship or barge and railroad cars.

Piers are usually provided with tracks located at their center or along the edge.

At locations where rail equipment is to be transferred to and from ships, car floats or ferries, transfer bridges will be needed.

#### 4.1.3.2 Terminal Track

Railroad trackage and its layout should be designed to allow switching of various segments of the terminal as efficiently as possible without interfering with the operations at other segments of the terminal. Depending on the size of the terminal, remote or separate tracks for railroad cars may be needed to support switching movements at rail/water facilities. Storage tracks may be needed for cars held for loading or unloading, and to accumulate cars carrying a specific commodity destined for a particular ship or barge. A terminal handling a variety of commodities may require a separate group of tracks or yard for classification. Car repair tracks and supporting facilities may also be needed. Separate tracks or tracks for interchange between rail carriers may be needed if multiple carriers are to serve the rail/water transfer terminal.

#### 4.1.3.3 Commodity Handling

Docks should be equipped with necessary conveyors, pipelines, car dumpers, crane, hoppers and any other equipment for handling special products. Large structural cranes may be needed to extend over docks and ships or barges to facilitate the handling of loads. Conveyor systems may be required to move products in bulk or units.

All equipment along railroad tracks, including loading booms and unloading connections, must be retractable to ensure that it meets the guidelines found in Chapter 28 of the Manual for clearances.

Adequate ground, pier, and/or warehouse storage areas are essential for products awaiting shipment. The location and arrangement of the storage space is important so there will be minimal interference with other terminal operations in handling the commodities.

#### 4.1.3.4 Government Inspections

Certain products may be subject to inspections by government agencies having jurisdiction over customs, agriculture, food, drugs, and other items. These agencies often must be provided with enclosed heated and air-conditioned offices, and with inspection areas having prescribed cleanliness, temperatures, lighting, plumbing, lifting and cutting equipment and other tools, refrigerated storage rooms, locker rooms, rest rooms, and other facilities. Means for holding and disposing wastes and rejected products must also be provided. Such offices and inspection facilities are often located within or adjacent to transloading buildings and facilities.

The following factors should be considered during design of facilities for specific products.

#### 4.1.3.5 Fire Protection

Water lines and hydrants are typically needed throughout the terminal for fire protection. Local fire protection agencies should be contacted to determine design requirements for sizing fire waterlines and locations for hydrants.

Contingent upon the level of potential fire hazards and outside emergency response capabilities, it may be prudent to provide a self-contained fire fighting unit in the terminal. Also, consideration should be given to providing on-site water storage.

### 4.1.4 COMMODITY SPECIFIC CONSIDERATIONS

#### 4.1.4.1 Granular Agricultural Commodities

The handling of granular agricultural commodities is typically in bulk shipments using unit trains or blocks of railroad cars. Some commodities, such as flour, may be handled in bags. Rail/water terminals handling bulk shipments typically require large grain storage bins at or near the dock to serve as an intermediate holding or "surge" facility for shipments to be transferred between transportation modes. In addition, an elevator may be required for mixing certain commodities or grades of commodities to fulfill the needs of customers.

##### 4.1.4.1.1 Ship Loading and Unloading

Ships may be secured at a wharf or pier and loaded/unloaded by a traveling machine or by cranes on the dock. Ships may also be loaded/unloaded by a machine which is fixed in position with the ship moving itself fore and aft on its own lines to present successive hatches to the machine.

Barge loading/unloading is generally similar to that for ships, except that barge moving machinery and loading/unloading equipment is typically shore mounted.

Shiploaders/unloaders should be designed and sized to handle the required transfer rates, with a reasonable margin and allowance for maintenance, movement between hatches and other time out-of-service. Equipment selection may be

commodity specific to the exclusion of efficiently handling other materials. Ship unloaders may be grab bucket, various arrangements of bucket elevator or marine leg, screw conveyors, pneumatic equipment or vacuum unloaders. Use of traditional ship's gear may be encountered. Site-specific environmental regulations may control or limit the choice of type, and may further require extensive sound and dust suppression.

#### 4.1.4.1.2 Railroad Car Loading and Unloading

Facility switching costs will be minimized by having both loaded and empty tracks equal in capacity to a day's production. Railroad cars may be moved through the loading facility by road locomotives with appropriate control equipment, yard locomotives, plant locomotives, car movers, or gravity. Conveyors, gravity loading chutes or pneumatic loaders may be used. Unless a dedicated supply of cars is used, cars delivered for loading may not be compatible with the commodity to be loaded and accommodations for cleaning of these cars will be required.

For unloading, the track arrangement and car progression are generally similar to those for car loading. Car unloading may be by rotary dump, coupled or uncoupled, by bottom dump into conveyor pits, stationary or in motion, or by mechanical excavators. Choice of equipment will be dictated by the volume and physical properties of the commodity to be handled.

#### 4.1.4.1.3 Moisture Content

While temperature is not usually of concern during the handling of granular agricultural commodities, moisture content affects the weight and value of the product and should be considered in the design of all handling facilities. Grain drying equipment may also be needed to alter the moisture content.

#### 4.1.4.1.4 Other Design Considerations

It is essential to eliminate or minimize open storage, spillage, and any other practice which may lead to contamination of surface or ground water. Often regulations governing these are very stringent. Water treatment, to conform with these discharge regulations, can be very difficult and expensive to provide.

Aside from the terminal being located at waterside, many of the design considerations for waterfront granular agricultural terminals and facilities are the same as for inland terminals. The design considerations for grain elevators are covered in the bulk-solid segments of Chapter 14. For specific subjects, refer to Section 4.4.1.

### 4.1.4.2 Automobile and Other Vehicle Loading/Unloading

A waterfront automobile and vehicle terminal provides facilities for the transfer of shipments of vehicles from ship or barge to railroad car or trucks, and/or from railroad car or trucks to ship or barge. The terminal consists of one or more docks (pier or wharves), operating buildings, roadways and vehicle parking areas and railroad tracks. Generally, this terminal will be separate from other cargo facilities, to ensure protection and security of the vehicles being handled.

#### 4.1.4.2.1 Terminal Size

The size of the waterfront automobile and other vehicle loading/unloading terminal will depend on the number of vehicles to be loaded/unloaded within a specific period of time, the length of the time vehicles are to be held at the terminal, and the method of operation. The terminal will generally require greater parking capacity than a similar land terminal.

#### 4.1.4.2.2 Loading and Unloading

The loading/unloading of ships or barges is generally accomplished through the use of onboard ramps which allow the vehicles to be driven or towed from the dock onto the ship or barge, or from the ship or barge onto the dock. Paved areas adjacent to or on the dock are often necessary to land the ramp and vehicles.

#### 4.1.4.2.3 Other Design Considerations

The site should be accessible to railroad switching from a line which is free of clearance restrictions for multi-level railroad cars typically used for automobile and truck loading.

Sources of airborne dust and pollutants which could damage vehicle finishes should be considered.

Aside from the terminal being located at waterside, many of design considerations for waterfront automobile terminals and facilities are the same as for inland terminals. These design considerations are covered in Section 4.3 of Chapter 14 entitled "Automobile and Truck Loading/Unloading Facilities".

### 4.1.4.3 Bulk Fluids

Waterfront bulk fluid terminals are specialized freight terminals which are used to transfer bulk shipments of fluids between ship or barge and railroad cars, or other modes of transportation.

This section is applicable to bulk liquids such as chemicals, petroleum, fertilizers, food-grade liquids and oils. Also, this section will apply to some dry bulk solids such as powders and granules, which have physical characteristics similar to a liquid, and are handled as fluids rather than as solids.

These commodities could transported in single or multiple railroad car block, or in unit train service. Some commodities, such as petroleum products, may be transported in railroad cars with interconnected piping to allow unloading and loading of several cars from a single point.

Factors affecting terminal and facility design include number and types of materials to be handled, the size of shipment (i.e., unit train, multiple car, single car, ship or barge), the physical characteristics of the site, and the degree of processing and storage to be done on the site.

#### 4.1.4.3.1 Loading and Unloading

Loading and unloading facilities at terminals may vary from low-volume, single, or multiple car customer systems to high-volume systems for unit trains. Contingent upon the function of the terminal and the commodities to be handled, the transfer of commodities may be between railroad car and truck, railroad car and storage tank, and/or truck and vessel. In any case, the terminal and its facilities must be carefully designed to meet the needs of its customer or customers.

For low-volume terminals, intermittent unloading of commodities is common and will impact the equipment needs for the terminal. For larger terminals, high-capacity equipment may be necessary.

In any situation, typical railroad car and truck length should be determined for the installation of loading booms or unloading connections at the appropriate interval. Careful consideration must be given to the type of commodity and railroad cars, trucks, vessels and loading/unloading equipment to ensure compatibility. Also, a careful analysis of the equipment, piping, connections, storage tanks, and other facilities should be done to ensure that they are composed of materials that will not corrode or deteriorate when exposed to the commodity.

#### 4.1.4.3.2 Other Design Considerations

It is essential to eliminate or minimize open storage, spillage, and any other practice which may lead to contamination of surface and ground water. Often regulations governing these are very stringent. Water treatment, to conform with these discharge regulations, can be very difficult and expensive to provide.

Spill containment slabs or pens, and a system for collection and treatment of spills is often required beneath loading booms and unloading connections.

Aside from the terminal being located at waterside, many of the design considerations for waterfront bulk fluid terminals and facilities are the same as for inland terminals. These design considerations are covered in Section 4.5 of Chapter 14 entitled "Bulk Liquids".

#### 4.1.4.4 Coal and Bulk Ore

The terminal may consist of a series of mooring dolphins with a structure for a shiploader/unloader, a pier or wharf with a rail mounted traveling shiploader/unloader, or an intermediate type.

##### 4.1.4.4.1 Ship/Barge Loading and Unloading

Ships may be secured at a wharf or pier in position one time and loaded/unloading by a traveling machine, by ship's gear, or by cranes on the dock. Ships may also be loaded/unloaded by a machine fixed in position with the ship moving itself fore and aft on its own lines to present successive hatches to the machine.

Ship loaders commonly are belt conveyor type, with appropriate slinger or other equipment to distribute cargo around the ship's hold. Barge loading/unloading is generally similar to that for ships, except that barge moving machinery and loading/unloading equipment is typically shore mounted.

Shiploaders/unloaders should be designed and sized to handle required transfer rates, with a reasonable margin and allowance for maintenance, movement between hatches and other time out-of-service. Equipment selection may be product specific to the exclusion of efficiently handling other materials. Ship unloaders may be grab bucket, various arrangements of bucket elevator or marine leg, belt or screw conveyors, pneumatic equipment or vacuum unloaders. Use of traditional ship's gear may be encountered. Self unloading ships exist which mount a slewing belt conveyor boom to deliver bulk material to shore.

Site-specific environmental regulations may control or limit the choice of type, and may further require extensive noise and dust suppression.

##### 4.1.4.4.2 Railroad Car Loading and Unloading

Facility switching costs will be minimized by having both loaded and empty tracks equal in capacity to a day's production. Railroad cars may be moved through the loading facility by road locomotives with appropriate control equipment, yard locomotives, plant locomotives, car movers, or gravity. Conveyors, gravity loading chutes or pneumatic loaders may be used. Unless a dedicated supply of cars is used, cars delivered for loading may not be compatible with the commodity to be loaded and accommodations for cleaning of these cars will be required.

For unloading, the track arrangement is generally similar to that for car loading. Car progression may be with road locomotives with appropriate control equipment, yard locomotives, plant locomotives, car movers or gravity. Car unloading may be by rotary dump (coupled or uncoupled), bottom dump (stationary or in motion), or by mechanical excavators. Choice of equipment will be dictated by the volume and physical characteristics of the commodity to be handled.

Unloading of materials that stick to the inside of the cars by excavating machines may require devices to secure cars, with a rapid set and release mechanism. Cleaning facilities may also be required. Unloading in winter may require cars and lading to be thawed in thawing or heating sheds.

##### 4.1.4.4.3 Material Stacking, Reclaiming and Handling

Equipment selected should be suitable to the material to be handled, to the site, and to the other facility equipment. Conveyor belt systems, level and inclined, with or without bucket elevators, are useful for many types of commodities. Use of air slides and airlifts, suitable for some commodities, provide a fully enclosed system with good dust control capability.

#### 4.1.4.4.4 Other Design Considerations

It is essential to eliminate or minimize open storage, spillage, and any other practice which may lead to contamination of surface and ground water. Often regulations governing these are very stringent. Water treatment, to conform with these discharge regulations, can be very difficult and expansive provide.

### 4.1.4.5 Intermodal

Aside from the terminal being located at waterside, many of the design considerations for waterfront intermodal terminals are the same as for inland terminals. These design considerations are covered in Section 4.2 of Chapter 14.

### 4.1.4.6 Perishables

Perishables commodities handled at ports may include fruits, fruit juices, juice concentrates, vegetables, meats, poultry, fish, dairy products, candy plants, cut flowers, pharmaceuticals, photography supplies, and chemical. Perishable commodities may be handled in bulk, usually in cartons with or without pallets, or in refrigerated railroad cars, containers or truck trailers. Some of these are shipped frozen at low temperatures, and others fresh at controlled temperatures to prevent overheating or freezing. In all cases, it is important to minimize the time taken to transfer one transportation mode to another to prevent spoilage.

#### 4.1.4.6.1 Buildings and Docks

Enclosed buildings are required to break, and sometimes mix bulk commodities for transloading to or from ships, rail cars, containers and truck trailers. Temperature controlled storage rooms are also required in such buildings if the commodity is temperature sensitive and delays in transloading are possible. These buildings should have exterior doors at rail car height and at truck height, and should be equipped with extendible shrouds which provide seals between railroad cars or trucks and the building to provide a protected environment during handling.

Outside docks should be wide enough to provide adequate maneuvering room for loading equipment. Lighting should be provided for night time operations.

See AREMA Chapter 6, for additional related information.

#### 4.1.4.6.2 Containerized Shipments

Containerized perishable commodities use refrigeration or heating units, ranging from -20 F (-29C) to +80F (+27C), which require electric outlets on shipboard, typically 460V, 60hz, 3. On docks, these containers may be plugged into on-shore power outlets provided specifically for that purpose, or powered by diesel-electric motor generator units, typically having a capacity of approximately 18kva, which are either fastened onto the top front nose of the container using fork lift, or mounted on the underside of the trailer chassis. If on-shore power is subject to interruption, a reliable stand-by power source should be provided.

Containers on railroad cars may utilize refrigeration equipment powered by individual, nose mounted motor generator units or by a central, removable power unit, typically 113kw, mounted in a container flat car which feeds up to nine containers on the same articulated car.

Most refrigerated truck trailers carry their own, built-in motor generator. Some equipment modifies its internal atmospheric pressure and is charged form tank trucks or gas bottles which may require storage areas at the terminal.

#### 4.1.4.6.3 Other Design Considerations

A facility should be provided near the facility for the cleaning, fueling, maintenance, repair, and preparing of railroad cars, containers, trailers, chassis and refrigeration and motor generator units. It should have technical equipment for testing, diagnosing and recording equipment performance. A secure, fenced and well lighted area should be provided for storage of spare parts and MG units.

See Section 4.2 of Chapter 14, for additional related information concerning containerized and truck trailer terminals.

#### 4.1.4.7 Phosphate Rock and Phosphate Chemicals

Phosphate rock and phosphate chemicals are different commodities which will likely have to be handled in separate areas to meet customer requirements. These materials must be handled, transported, and stored in a dry state. Prevention of moisture intrusion and contamination is essential. Facilities should be designed to avoid product degradation.

##### 4.1.4.7.1 Environmental Considerations

Dust collection is essential for all storage facilities and transfer points. Dry dust collection is strongly preferred because the product can be returned to the system. Wet scrubbers should only be considered to meet the most stringent air quality requirements. Fully enclosed dumpers and conveyor transfer points with dust collection should be provided. Telescoping chutes with encapsulated dust collection must be provided for ship or barge loading. Measurement of loading point air quality (opacity) is a less-than-precise science which should be considered in attempting to meet local air quality standards.

Local air quality standards may specify the annual amount of pollutants that may be discharged into the air which in turn may limit the hours of operation for a particular transfer terminal.

It is essential to eliminate or minimize open storage, spillage, and any other practice which may lead to contamination of surface and ground water. Most states or municipalities have laws or regulations which stipulate the amount of nitrogen or phosphate that can be contained in water discharge. Often these regulations are very stringent. Water treatment, to conform with these discharge regulations, can be very difficult and expensive to provide.

##### 4.1.4.7.2 Storage

Storage facilities must be enclosed from the weather, and provide compartments to separate rock and various grades of chemical. Additional separation may be needed if there is more than one customer. Dust collection may be needed and curtains may be required to prevent transport of dust between rock and chemical.

##### 4.1.4.7.3 Rail Equipment

Phosphate rock and chemicals are normally transported by rail in covered hoppers. Unloading is usually done by rotary dumping to allow elimination or sealing of bottom hatches. Cars should be dry cleaned, mainly to avoid the environmental difficulties associated with disposal of wetted product.

##### 4.1.4.7.4 Maintenance

Special attention must be given to prompt cleanup of material resulting from normal or accidental material spillage. Scheduled maintenance to clean pulleys, rollers, dumping equipment, pipes, chutes, etc. must be provided to assure efficient operation and extend equipment life.

#### 4.1.4.8 Other Miscellaneous Cargoes

Aside from the terminal being located at waterside, many of the design considerations for other cargoes are the same as for the inland merchandise terminals. These design considerations are covered in Section 4.6.

### 4.1.5 TERMINAL MAINTENANCE

Bulk materials facilities should be designed to minimize maintenance and provide for adequate housekeeping. Areas where material spills are likely should provide access for loaders and trucks for easy removal of spillage. Particular attention should be given to the prevention of dust accumulation. Materials used in construction should be resistant to deterioration from the commodities handled.

Every effort must be made to avoid product discharge into harbor waters, not only to maintain compliance with regulations, but also to avoid contamination and special handling of dredge materials when maintenance dredging is required.

The design of the terminal should include provisions for ongoing maintenance and staged replacement of components. Areas should be provided within the limits of the facility for storage and easy access to routinely used maintenance materials and equipment. Fueling and maintenance facilities for mobile and fixed equipment should also be provided.

Use of secondhand rail, ties, or turnouts should be kept to a minimum and used only in areas where track can be easily removed from service without unduly restricting the overall use of the facility. The main switching leads and areas that will be either paved over or located immediately adjacent to fixed elevation pavements or mechanical systems, should be constructed with new premium or first grade material. Care must be taken during track maintenance to hold the elevation of the rail to within the designed tolerances.

Drainage structures and pavement slopes should be designed to avoid temporary ponding of water and allow easy removal of debris. The use of subsurface drains should be included in confined areas, such as track roadbeds within paved areas, to provide an outlet for moisture infiltration.

## SECTION 4.2 DESIGN OF INTERMODAL FACILITIES

### 4.2.1 INTRODUCTION (1993)

Intermodal terminals are specialized freight terminals designed to efficiently transfer trailers and/or containers to and from rail cars. Trailer on flat car/container on flat car (TOFC/COFC) operations involve mounting trailers or containers on specially equipped flatcars. Double-stack intermodal operations involve placing one container on top of another on specially designed rail cars that support the containers at a height of about one foot above the top of the rails. Intermodal terminals integrate rail, highway and waterway transportation modes. For additional pertinent information on design of TOFC/COFC Facilities, refer to Bulletin 696, Proceedings Volume 85, May 1984, Pages 157-190.

#### 4.2.1.1 General

Factors influencing the facility location and design are accessibility to major highways and water routes, and capacity and clearance capability of the serving rail lines. The location studies must consider the equipment type, the traffic volume, railroad operations, highway traffic patterns and central location with respect to market area. There must be a commitment from railroad management concerning the general area where an intermodal or TOFC/COFC terminal is desired.

##### 4.2.1.1.1 Operational Concept

a. The design of an intermodal or TOFC/COFC terminal will be governed principally by the volume of intermodal traffic, the land available, storage requirements and the existing layout for expansion projects.

b. A waterfront terminal serving a port handling container ships usually requires more storage/parking area than an inland terminal unless the operations of the two facilities are closely coordinated. Waterfront terminals will frequently be called upon to handle high volumes of movements on peak days and stand idle the remainder of the week. Operations commonly handling perishable loads have different needs since electrical outlets and additional fuel supplies are required to keep the refrigerated units running.

c. Standards should be developed to permit efficient truck-trailer movement between the terminal gate and the parking areas. A computer program to help locate and retrieve trailers and containers will permit more efficient location assignments for incoming and outgoing trailers.

d. A centralized management information system will facilitate trailer handling, spotting, preblocking and all associated paper flow.

#### 4.2.1.1.2 Rail Equipment Considerations

a. A variety of specialized rail equipment is used in the transport of trailers and containers. Trailer carrying railcars provide a supporting platform for the trailer wheels and a stanchion to support the trailer at the king pin. The stanchion latches the king pinto provide longitudinal restraint to the trailer. Some of these railcars have continuous platforms and short bridge plates to span the gap between coupled cars, thus allowing the trailers to be driven onto and across the cars. Lighter cars have platforms only at specific support points and require that all trailers be lifted on and off the cars.

b. Containers are carried on two basic types of cars. These are single-level cars similar to those used for trailers and double stack cars specifically designed to carry two containers stacked one on top of the other. Single level cars have special fittings that support and secure the corner castings of standard containers. Two types of double-stack car designs are in use. Both carry the lower container in a "well" with the bottom of the container supported approximately one foot above the top of rail. Bulkhead cars restrain the top container from longitudinal and lateral movement with bulkhead guides at all four corners of the container, holding the lower one foot of the container in place. The weight of the container is sufficient to prevent the container from bouncing out of the guides. Double-stack cars without bulkheads require the use of twist-lock inter-box-connectors (IBC's) to secure the upper box to the lower box. The IBC provides both horizontal and vertical restraint for the upper box. All containers must be lifted on and off the rail cars using various types of lift equipment that is generally dedicated to use at a given intermodal terminal.

### 4.2.1.2 Site Selection Planning

a. Many of today's TOFC/COFC terminals are inadequate because they were originally designed to conform to an available site. This approach should be avoided if at all possible.

b. Layout and planning for the facility should include the following elements:

#### 4.2.1.2.1 Environment

Environmental factors to be considered include:

a. Air.

b. Water.

c. Noise and Lighting.

d. Rainfall Runoff.

e. Archaeological and Historical Sites.

f. Housing Displacement.

g. Proximity to Residential Areas.

h. Wetlands.

i. Floodplains.

j. Difficult soils conditions.

#### 4.2.1.2.2 Economics

The ideal facility topography is relatively level with good cross drainage and stable foundation material. The site should allow a design that facilitates through train pickup and set-out, or termination and origination where possible. A minimum of switch engine moves should be used to assure the most economical return.

#### 4.2.1.2.3 Traffic Volume

Projected traffic volumes and possible future volumes will influence layout and traffic circulation plans.

#### 4.2.1.2.4 Size

The size of a terminal depends on the number of trailers/containers loaded and unloaded in a specific time period, the length of time the trailer/container is held at the facility and the method of operation. Space is often limited and expensive, which therefore leads to more mechanized storage and handling systems.

#### 4.2.1.2.5 Standardization

Standardizing certain elements of a TOFC/COFC terminal is desirable. This will permit the future transfer of terminal equipment from one terminal to another.

#### 4.2.1.2.6 Highway Access

Good highway access is essential to the proper TOFC/COFC terminal siting. Highway load restrictions and clearances must be considered.

#### 4.2.1.2.7 Rail Access

The approach tracks should be free from rail traffic congestion and have the proper rail clearances. If the daily volume of an intermodal terminal exceeds the track capacity of that terminal, additional support yard trackage will be required to accommodate arriving and departing trains and additional car storage.

#### 4.2.1.2.8 Zoning

Most governmental jurisdictions have zoning laws that govern constructing the facility. It is highly desirable to avoid sites near residential areas or sites that require rezoning, as this is often a lengthy process with limited prospects of successful results.

### 4.2.2 FACILITY TYPES AND EQUIPMENT (1993)

a. Committee 6, Assignment 1 entitled "Buildings, Platforms Ramps, Paving, Lighting and Other Facilities for Piggyback Terminals," in Bulletin No. 625, Proceedings Volume 71, January 1970 describes mechanical loading considerations, loading methods and yard design considerations.

b. There are three types of TOFC/COFC facilities: end, side and overhead loading and unloading. Each has different cycle times.

#### 4.2.2.1 General

The approximate cycle time for each method during typical TOFC/COFC loading/unloading operations is five min. for end-loading: two and one-half to three min. for side-loading (TOFC): and one and one-half to two min. for overhead loading (TOFC).

#### 4.2.2.2 Volumes

Three ranges of TOFC/COFC facility volumes are discussed and are defined as the total number of trailers or containers loaded or unloaded in each 24-hr day.

##### 4.2.2.2.1 Low Volume - Less than 100 Lifts/Day

Low volume terminals are characterized by infrequent train service. Some parking or yard space is necessary. In many cases, trailers can be ramped as they arrive.

##### 4.2.2.2.2 Medium Volume - 100 to 300 Lifts/Day

Medium volume terminals are designed to maximize the availability of trackside parking. Ramps can be used although cranes and side-loaders are preferred.

##### 4.2.2.2.3 High Volume - 300 and More Lifts/Day

a. High volume terminals are distinctly different from low and medium level terminals in configuration, equipment and method of operation. They are usually designed to use side-loaders or overhead cranes for loading and unloading.

b. When a trailer enters the terminal area, the trucker may be directed to leave the trailer in a specific parking area or deliver it to trackside for loading. Hostlers pick up trailers from assigned parking spaces and spot them at trackside before loading operations begin.

c. The rail unloading cycle works in a similar manner but in reverse.

#### 4.2.2.3 End-Loading (Fixed or Portable Ramps)

Railroad cars are end-loaded by backing the tractor-trailer combination onto a flat car or string of cars using a platform or ramp constructed at car-floor height. The reverse procedure is used to unload trailers.

#### 4.2.2.4 Side-Loading

Side-loading and unloading can be done by a forklift truck, a platform at car-floor height, a depressed track or by special equipment which permits separating the trailer body from its wheels and placing the body on a flat car.

Side-loaders have poor weight distribution which increases both the subsurface density and paving thickness requirements, and thus, greatly increases construction costs.

Side-loader characteristics vary depending upon the manufacturer. The following list displays key information regarding the major types of side-loaders now in use:

a. Capacity: 44,000 to 90,000 lb.

b. Minimum aisle: 30 to 55 feet.

c. Ideal aisle: 55 to 75 feet.

d. Turning radius: 20 to 52 feet.

e. Transport to storage area: Yes.

f. Speed: 9 to 26 mph.

g. Stacks containers.

### 4.2.2.5 Overhead Loading

a. Gantry cranes permit overhead handling of containers and trailers. The cranes may be rubber-tired or rail-mounted, either of which permits picking up trailers or containers from the roadway adjacent to the track and longitudinal movement from car to car. Rubber-tired cranes often require reinforced concrete runways to support the wheel loads, while a rail-mounted crane requires a firm foundation to support the crane rail.

b. In an overhead crane operation, a trackside parked trailer or container is lifted vertically and moved laterally to the flat car, and lowered onto the car. Ground operations supporting container loading/unloading operations are more complex because the bogies or chassis must be brought trackside.

c. The characteristics of gantry cranes vary depending upon the manufacturer. The following list displays key information regarding the major types of gantry cranes now in use:

(1) Capacity: 50,000 to 100,000 lb.

(1) Span (rubber-tired): 32 to 76 feet.

(2) Transport to storage area: possible with rubber-tired units.

(3) Stacks containers: four high (maximum; however, not normally desired).

(4) Turning radius: generally five feet over gantry width.

(5) Number of lifts per day: 360.

d. Straddle carriers (Van carrier) also provide overhead loading capabilities. Unlike the gantry crane, the straddle carrier provides both the lifting and transport functions. The straddle carrier picks up the trailer or container at its current place of rest by straddling it and lifting it. The straddle carrier then transports the unit to the end of the string of railcars to be loaded. The unit then travels over the railcars, straddling the track and car, carrying the trailer or container in an elevated position. Upon reaching the car to be loaded, the unit is lowered into position. The process is fully reversed for unloading.

e. The characteristics of straddle carriers vary depending upon the manufacturer. The following list displays key information regarding the major types of straddle carriers now in use:

(1) Capacity: 50,000 to 100,000 lb.

(2) Span (rubber-tired): 15-20 feet.

(3) Transport to storage area: eliminates the need for an independent hostling vehicle.

(4) Lift height: One trailer over trailer on flat car; one container over two containers on a double-stack car.

(5) Turning radius: 35 feet outside radius.

(6) Number of lifts per day: Depends on travel distance to staging area.

(7) Travel speed: 23 mph.

f. The choice of equipment characteristics must be made in concert with other facility development issues, such as: track centers, traffic flows and operating volumes.

#### 4.2.2.6 Parking/Staging Equipment

##### 4.2.2.6.1 Containers

a. Yard tractors include flatbed trucks and trailers/chassis units which move containers from trackside to the parking area.

b. Straddle-carriers are specialized units designed to transport one container at a time between trackside and the parking area.

c. Heavy-duty forklift trucks are used for stacking and repositioning containers.

d. Travel cranes are mounted on either rubber-tired wheels with straddle widths up to 75 feet or rail mounted with straddle widths up to 200 feet.

##### 4.2.2.6.2 Trailers

Trailers are usually moved between trackside and the parking area by a yard or road tractor.

#### 4.2.2.7 Standard Rail Cars

The type of railroad cars to be used in the facility must be considered in the design. The 89-foot flatcar is the normal car presently used for TOFC/COFC service. However, the trend is toward longer cars carrying two of the longer highway trailers on a flat car.

#### 4.2.2.8 Special Intermodal Cars

Various kinds of intermodal cars have been designed to reduce weight, improve aerodynamic efficiency, improve train handling characteristics to reduce damage to lading, reduce fuel consumption, reduce the number of locomotive units needed to move a given consist and improve terminal operation. Several types of cars now in common use include:

##### 4.2.2.8.1 Single Platform Skeleton Cars

These cars are designed to carry containers or trailers on a lightly framed car. These cars are generally equipped with special single axle trucks at either end of the car. Each car is capable of carrying one trailer or one long or two short containers.

##### 4.2.2.8.2 Articulated Skeleton Cars

These cars are generally made up of five independent platforms similar to the single platform cars. The five platforms are carried on a total of six two axle trucks. Each platform is capable of carrying one trailer or one long or two short containers.

##### 4.2.2.8.3 Single Platform Double-Stack Well Cars

These cars carry one or two containers in the well and one more container on top of those in the well. The top container is secured to the lower container(s) with inter-box-connectors (twist locks).

##### 4.2.2.8.4 Articulated Double-Stack Well Cars

These cars consist of five well car type platforms connected with articulated couplings, and carried on six two axle trucks.

##### 4.2.2.8.5 Articulated Double-Stack Bulkhead Car

These cars are very similar to the well type car except that the upper container is held in place by fixed or adjustable bulkheads located at each end of each platform.

#### 4.2.2.8.6 Articulated Well-cars

Articulated well-cars, some with a mix of trailer and container carrying capabilities.

#### 4.2.2.8.7 Stand-Alone Well Cars

These cars are basically a series of single platform well cars connected with rigid drawbars in order to achieve a train with a minimum of slack action.

#### 4.2.2.8.8 Dual-mode Vehicles (Rail/Highway Vehicle)

These vehicles are specially designed highway trailers that either have a single rail axle permanently mounted to the trailer, or connect to a special two axle rail boggie. The individual units are connected to each other in elephant train fashion. A special connector on the nose of one trailer is used to connect that trailer to a receiving socket at the back of the preceding trailer. A large pin locks the two units together.

#### 4.2.2.9 Trailers

The size and weight of truck trailers operating over highways are controlled by state and federal law. Federal Law permits up to 80,000 lbs gross weight, trailers up to 102 inches wide and semitrailer portion of a tractor-semi-trailer combination up to 53 feet long on sections of the federal aid primary system highways. The allowable load limits and the seasonal weight restrictions on the access roads to the TOFC/COFC terminal are important.

#### 4.2.2.10 Containers

Containers come in a variety of common sizes, however their fittings and securement devices are usually standardized based on the location of these devices on 20 feet and 40 feet ISO (International Standards Organization) marine containers. Common container lengths include 20 feet, 40 feet, 45 feet, 48 feet and 53 feet. 24 feet and 35 feet containers are found in the fleets of some steamship lines. Introduction of a 28-foot unit is anticipated. Widths are generally 96 inches or 102 inches with heights being 4 feet, 8 feet, 8′-6″ and 9′-6″.

#### 4.2.2.11 Securement

a. Trailers are secured to the railcar with a stanchion support that locks onto the trailers kingpin. These stanchions may be a fixed type if the car is only designed for TOFC service. The stanchions are retractable if they also accommodate container service or if they are designed for loading by the "End Loading" method (Article 4.2.3.1.1). Two types of retractable tie-down mechanisms or trailer hitches on flatcars are presently in use, the "wrench-operated" and "tractor-operated." Trailer wheels are not secured, but lateral movement is resisted by curbs in the wheel support area.

b. Containers are secured in a variety of ways. On flat cars or most skeleton cars, the container is supported on pedestals at all corners. The pedestal provides vertical support plus lateral and longitudinal restraint. A special spring clip provides vertical restraint. Double-stack container cars restrain lateral and longitudinal motion of the lower container with fixed guide pins on the support plate. These pins mate with a standard casting on the container at the 40′ ξ 96″ location. The container sits deep within the frame of the car so that lift out is not a problem. For well cars, the upper container is locked to the lower container using standard marine type interbox-connectors at the 40′ ξ 96″ location. On bulkhead cars the upper container is also supported on the lower container, but all other restraint is provided by the bulkheads. A special saddle is being proposed to carry two 28 foot containers in the upper position on double-stack well cars.

#### 4.2.2.12 Chassis

Provisions for chassis storage should be made in the design for all terminals that will handle containers.

## 4.2.3 DESIGN FACTORS (2004)

The design factors that must be considered include the type of terminal, layout and configuration, pavement types, parking and storage, security, facility services, environmental controls, the terminal buildings and the maintenance and service buildings.

### 4.2.3.1 Terminal Types

The facility should be designed so the truck driver can check in at the gate and then park the trailer in a well-marked parking area or at an assigned trackside position for subsequent loading.

#### 4.2.3.1.1 End Loading

a. The ramps for stub-end tracks can be constructed from timber, steel, or concrete filled with earth. Tracks for two-directional unloading can be provided by paving an area level with the top of rail on which a portable ramp may be maneuvered. Portable ramps can be used to eliminate the need to turn cars. The unloading track must be tangent. Between-track platforms or platform walkways adjacent to the tracks are desirable. These platforms, which permit easy worker movements between cars, should be about 2′– 3″ wide and 3′– 6″ high or car floor-height. Laws governing track clearances affect the width of these platforms.

b. A small efficient low-volume end-loading terminal with the configuration shown in Figure 14-4-1 can handle 30 to 50 trailer loadings per shift. The configuration will vary in accordance with the land available.

#### 4.2.3.1.2 Side Loading

a. The track and adjacent parking configuration shown in Figure 14-4-2 with a length of five to ten cars can easily handle a volume of 50 lifts per shift. This low-volume configuration can be expanded for higher-volume terminals: up to 300 lifts per day can be attained with multiple-shift operations. The single track facility can be readily expanded as shown in Figure 14-4-3 and Figure 14-4-4. A second track is added about 110 feet from the first track, with its own adjacent parking area outside of the track area. One-way traffic flow should be provided to minimize interference with the load/unload operation.

b. Traffic control and communications become very important when a medium-volume terminal approaches a volume of 300 lifts a day. An efficient operation will, therefore, require road and parking stall markings and signing.

c. An alternative to the outside parking shown in Figure 14-4-3 is a configuration with adjacent parking between the two tracks as shown in Figure 14-4-5. The traffic-flow patterns are good with minimum interference with the side-loading operation.

d. Side loading of containers requires the coordinated efforts of the equipment operator and several truck or hostler drivers as the container chassis must be removed from trackside to allow the equipment to approach the railcar.

#### 4.2.3.1.3 Overhead Loading

a. Replacing side-loader equipment with crane-loading equipment should be explored when lift volumes approach 250 to 350 lifts per day. Overhead loading is usually provided at high-volume terminals with 300 or more lifts a day. The high-volume terminal shown in Figure 14-4-6 equipped with two cranes can be used for daily volumes in the range of 300 to 600 lifts a day. This terminal configuration can then be expanded from 600 to 1,200 lifts a day by adding tracks and cranes. Figure 14-4-7 and Figure 14-4-8 show a configuration for loading double stack rail equipment using long span and short span overhead equipment.

b. Terminal operators will vary in their opinion regarding the merits of sidelift equipment versus overhead lift equipment. This is generally a speed vs. flexibility argument. The overhead equipment has faster cycle times and is very efficient when moving from one end of the track to the other loading or unloading a unit at each position. Side loading

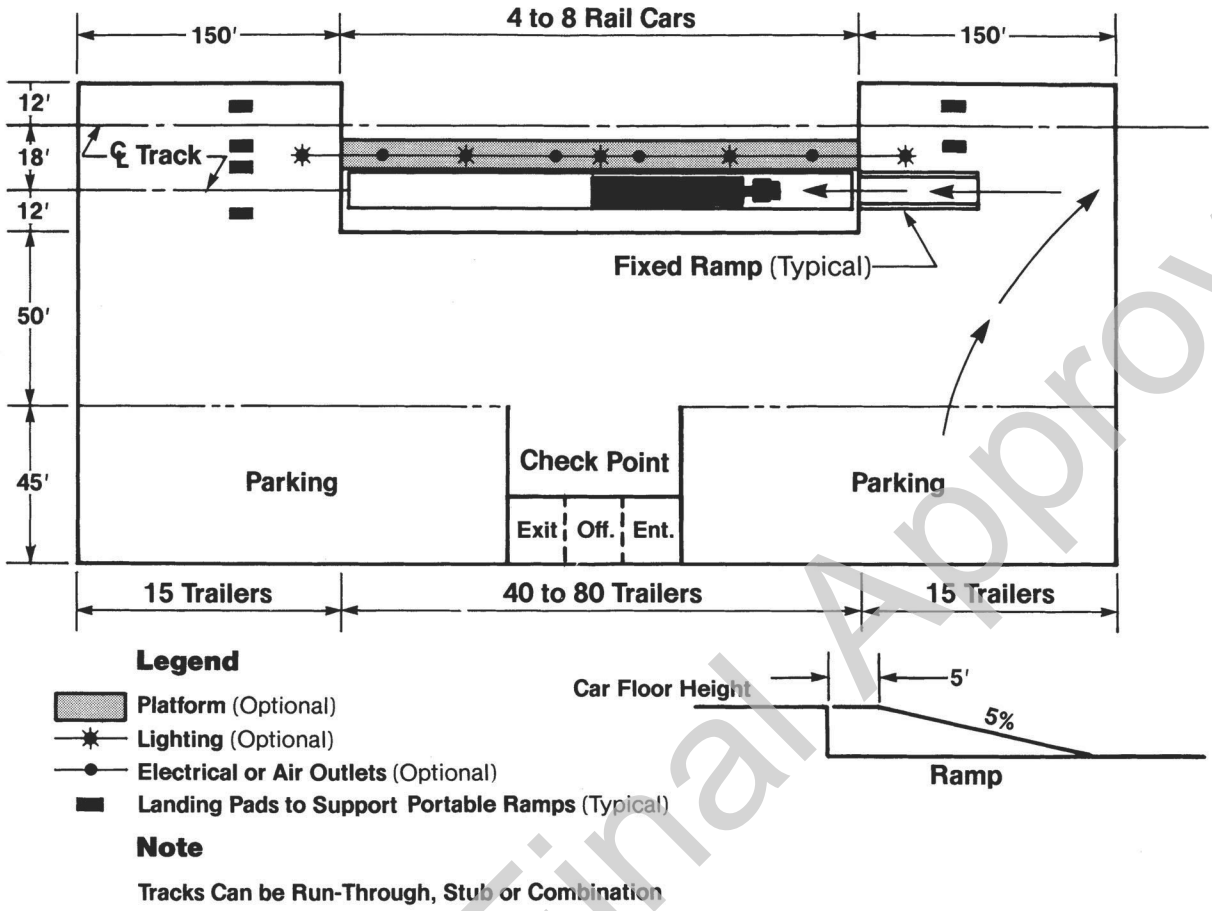


*Figure 14-4-1. Low-Volume Terminal with End Loading*

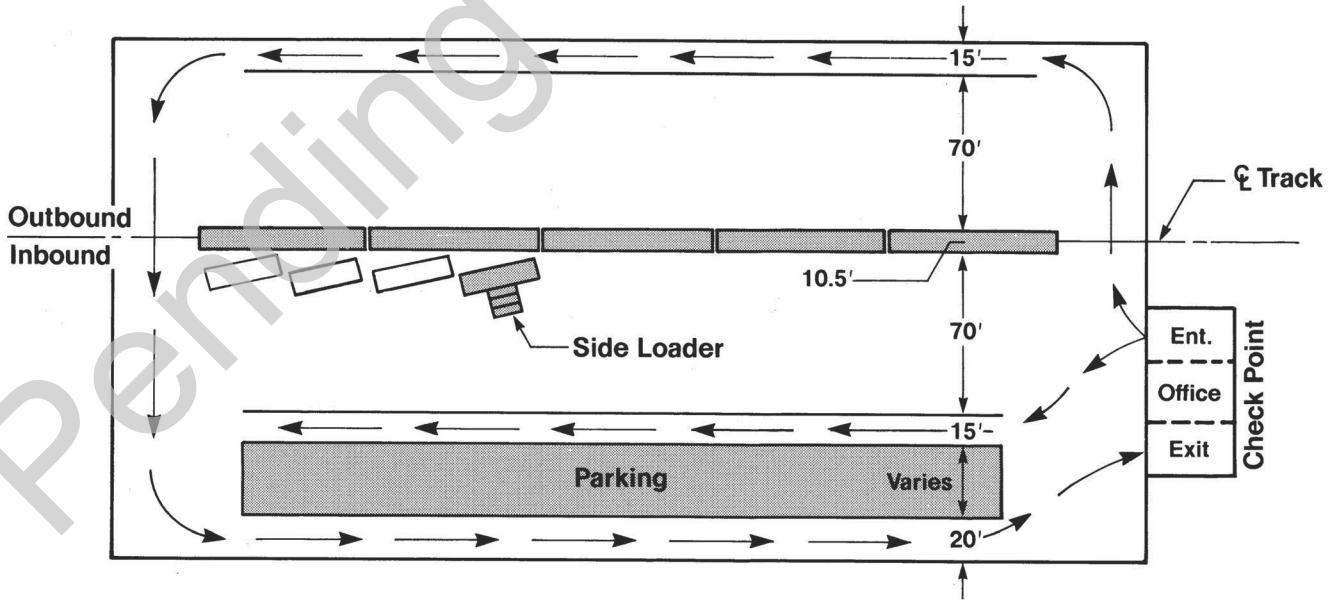


*Figure 14-4-2. Low-Volume Terminal – Side Loading*

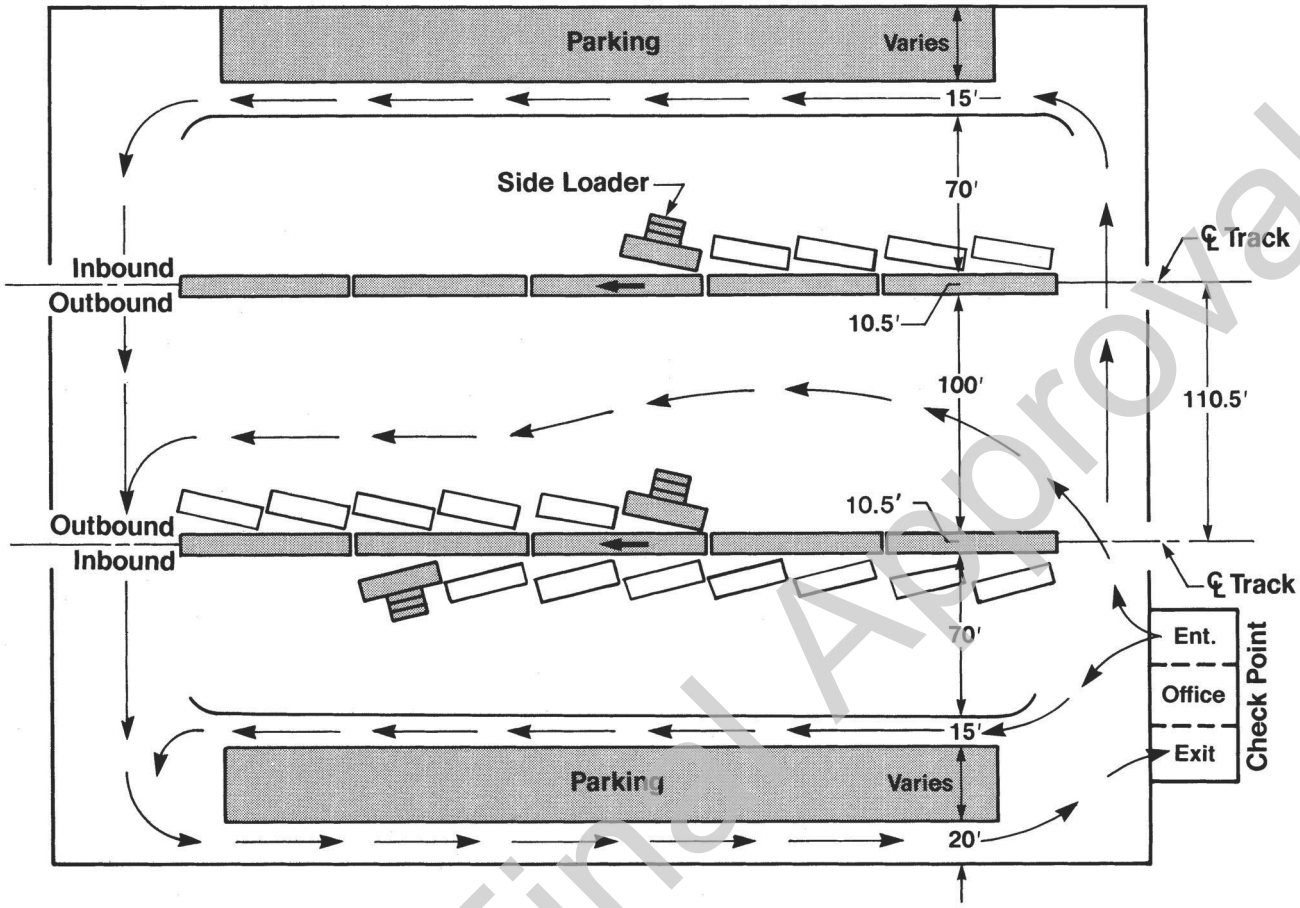


*Figure 14-4-3. Medium-Volume Terminal with Side Loading and Outside Parking*

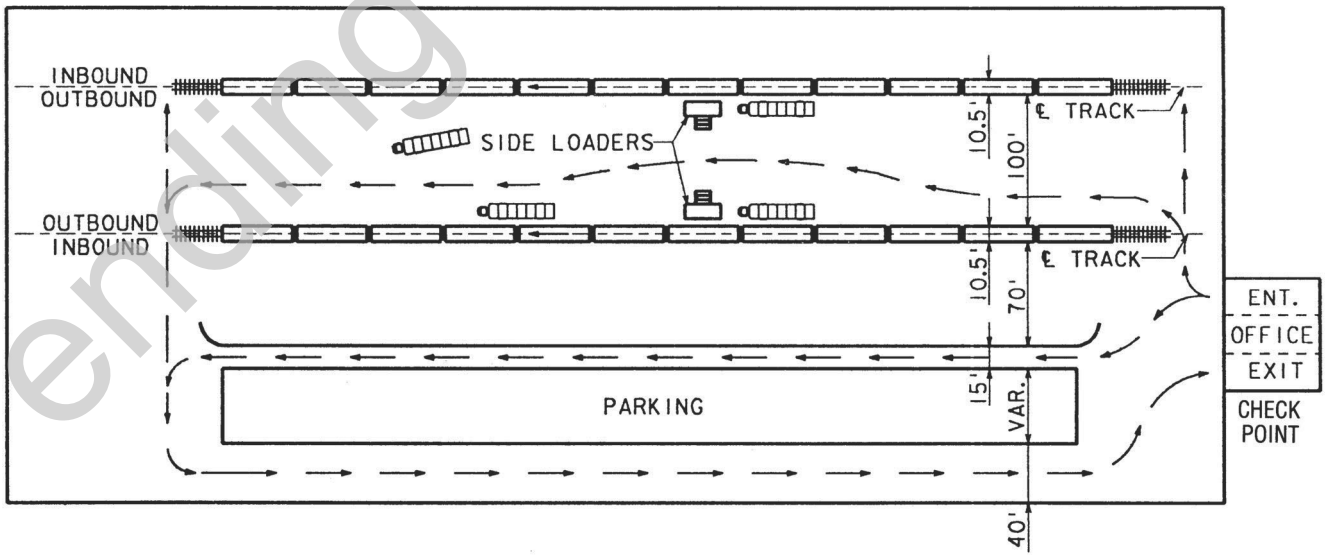


*Figure 14-4-4. Side Loading Double Stack Cars Between Parallel Tracks*

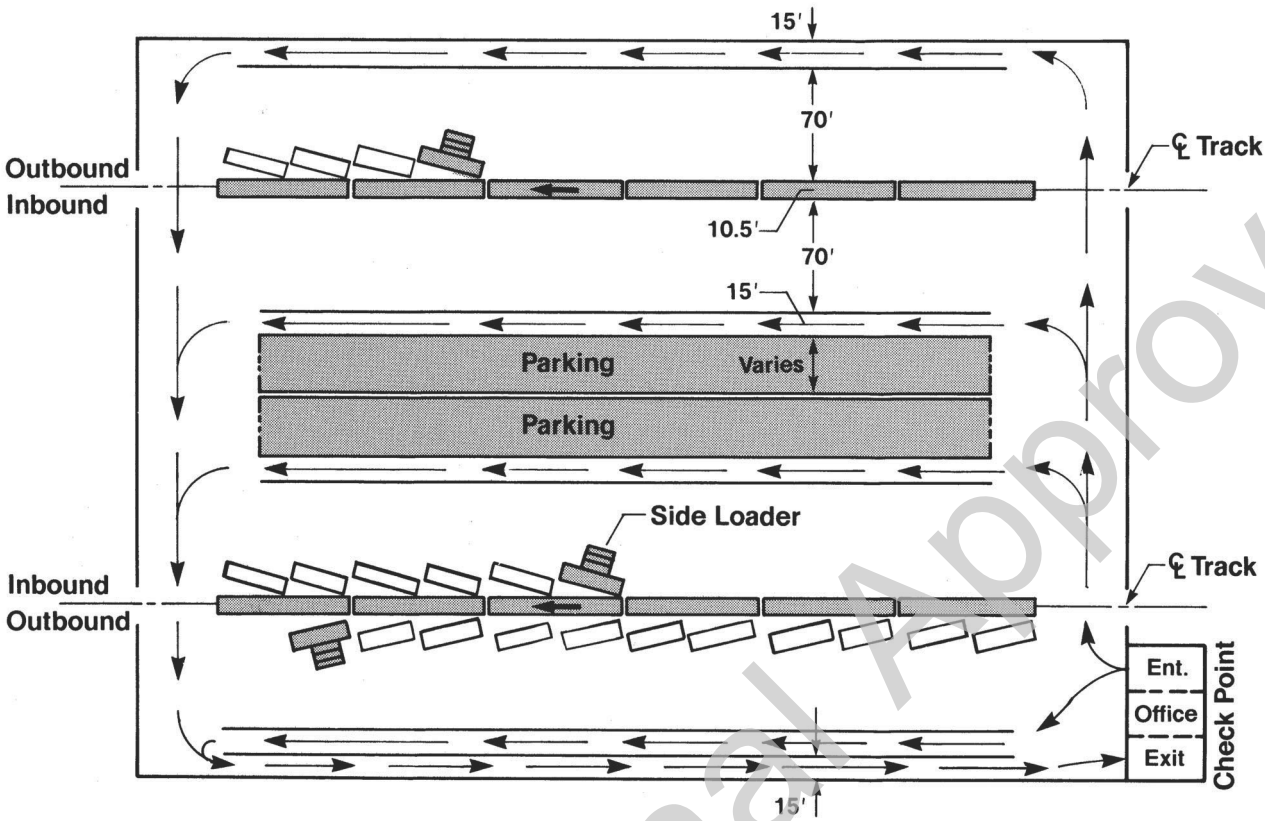


*Figure 14-4-5. Medium-Volume Terminal with Side Loading and Inside Parking*

equipment generally has a higher ground travel speed allowing it to move around the facility quicker to handle "Hot" loads at random locations.

c. Expanding terminals to volumes of more than 1,000 lifts a day should be considered only after a very thorough analysis has been made of truck-traffic flow-patterns. In major cities where volumes of these magnitudes may be available, the efficiency of several high-volume terminals located at strategic points around the city should be contrasted with the efficiency of a single very-high-volume terminal.

#### 4.2.3.1.4 Lift and Travel Loading

Straddle (van) carriers provide a variation on the other mechanical systems in that the lift and travel functions are provided by a single piece of equipment. This approach allows a terminal to expand through a range of throughput rates without altering the basic organization of the facility.

### 4.2.3.2 Layout and Configuration

a. The type of loading-unloading equipment to be used in a terminal influences the terminal layout and configuration.

b. Terminal layouts also affect the efficiency of loading/unloading and parking activities. Rail-mounted cranes require the least amount of lateral space but may complicate the problem of movement between rail cars. Rail-mounted machines are used where they can serve several tracks from a single travel path. While portable ramps are inexpensive, access room is required at the end of the rail cut. Side-loaders are flexible, but need adequate operating space between parallel tracks. Rubber-tired, overhead-lift equipment can function in a wide range of layout widths, but when configured for the maximum operating flexibility has the widest site requirement per track. Van carrier systems require the least site width per track of all the mechanized systems, but always require an independent parking area. The parking area for a

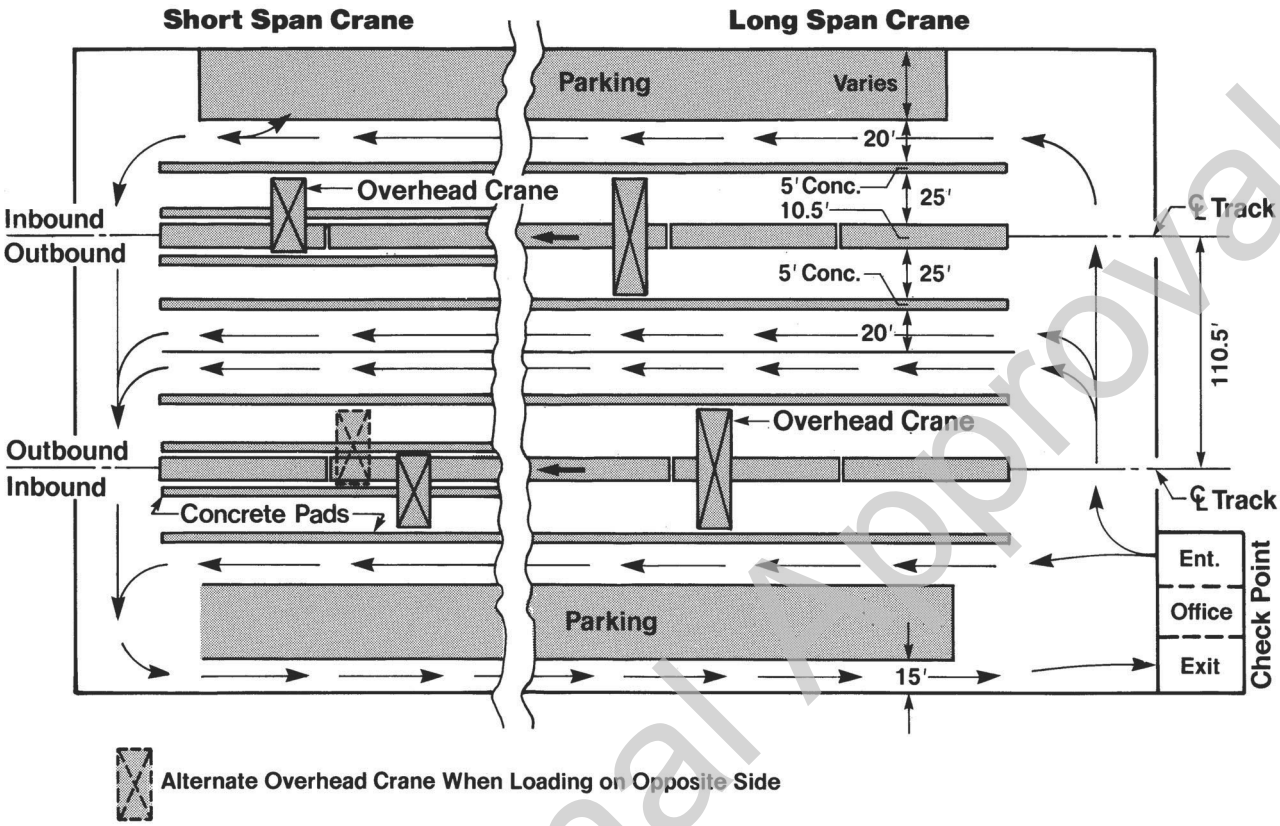


*Figure 14-4-6. High-Volume Terminal, Crane Loading with Outside Parking*

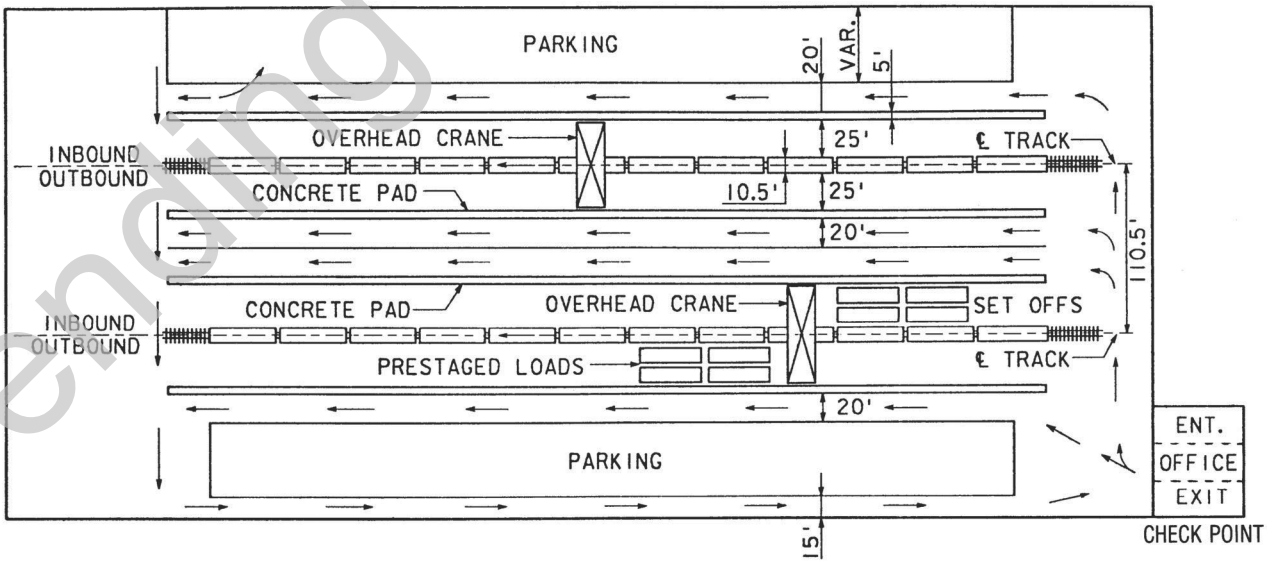


*Figure 14-4-7. Long Span Crane, Single Track with Double Stack Cars*

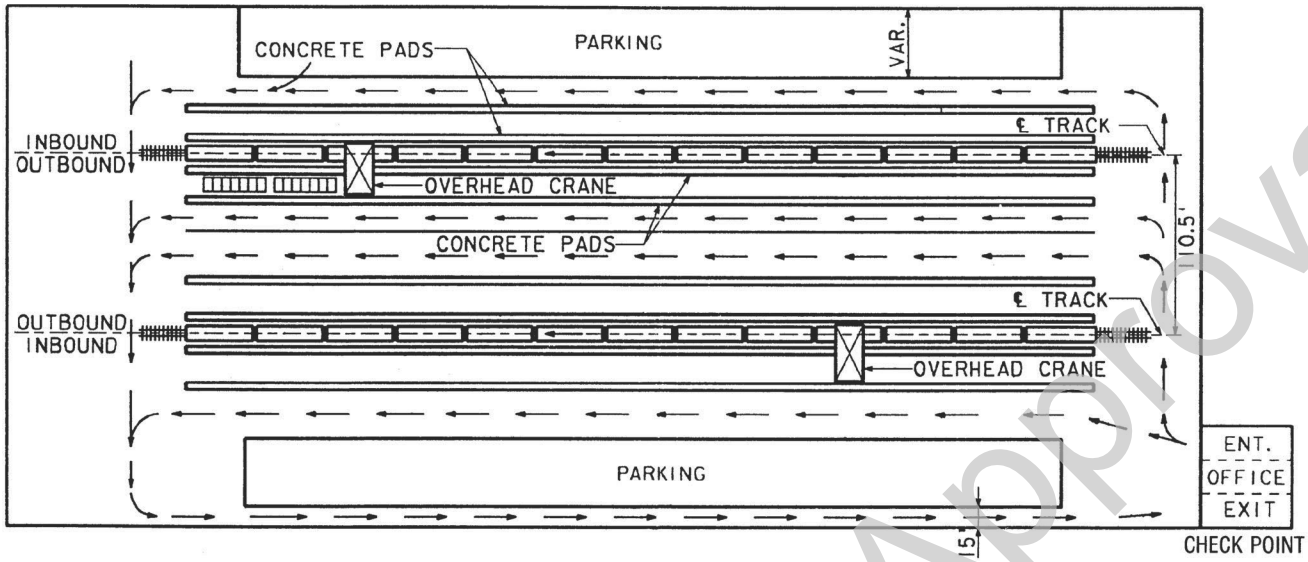


*Figure 14-4-8. Short Span Crane, Single Track with Double Stack Cars*

van carrier facility requires more land per parking stall than other systems because of pathways required for the carriers wheels. The requirements of a combination TOFC/COFC facility should be considered when determining the most effective equipment and layout.

c. Medium-volume terminals consist of multiple parallel tracks with the appropriate space between each set of tracks for equipment operation. The tracks vary in length from about 1,000 to 3,000 feet and are usually stubbed although some facilities have flow-through trackage.

d. High-volume terminals have typical track lengths of 3,000 to 8,000 feet with a driveway crossing near the middle for ease of trailer handling by yard hostlers. High-volume terminals can handle up to 1,000 units per day flowing through the facility. The typical high-volume terminal does not have the track capacity needed for a full day's volume of rail car traffic and cars must be pulled into or out of the facility several times a day.

e. Curves on the approach track should have the longest radii possible, with a minimum allowable radius on a constant vertical gradient of 441.68 feet (13 degrees). Due to extreme length of rolling stock, design of minimum radius may result in operating difficulties.

### 4.2.3.3 Pavement Systems

#### 4.2.3.3.1 General Considerations

There are a variety of requirements for pavement design considerations at TOFC/COFC terminals.

a. The capacity to support parked, loaded semi-trailers and containers based on short and long term projections of equipment utilization.

b. The capacity to support lifting equipment while carrying and lifting maximum loads. (Side-loading equipment in particular have heavy concentrated front-wheel pressures when under load, and under the steering wheels when empty.)

c. The pavement should require minimum maintenance because closing part of the terminal for such work can seriously impair service to customers as well as cause operating problems.

d. Long and short term planned facility development should be considered as business types (trailer vs. container), and customer base may effect pavement considerations. Potential changes in labor organization contracts (ports), operations/ownership, track expansion, ingress, egress, loading equipment, initial capital cost, pavement life, and serviceability all play a role in pavement design.

#### 4.2.3.3.2 Design Criteria

Most pavement design models incorporate four key components: soil condition, environment, design loads, and pavement life/serviceability. Of these, the first two are site-dependent, with in-situ mitigation measures the only means to change the input parameters.

a. *Design Loads.* Vehicular loading can be classified as four types:

(1) Loading/Lift equipment

Loading equipment generally takes one of four forms; side-loading, reach-stackers, gantry crane, or straddle carrier. Side-loading and reach stacking equipment, though extremely flexible, have a highly concentrated load about the front axle. The mobility of these machines generally requires significant increased pavement depth over a large area (effectively all areas where the equipment can be operated). Further, the tight turning radii relative to the machine's size cause significant lateral surface loads, which can lead to rutting and plastic flow of paving materials. Typical loading ranges and footprints can be found in figures/tables following text.

Gantry cranes and straddle carriers generally have a more evenly distributed wheel loading. Furthermore, their mobility throughout the facility is generally concentrated along defined runways adjacent to the tracks or over blocks of stacked containers. However, the overall vehicle weight coupled with the concentration of loading cycles generally results in the paved runways being at least as substantial as pavement designed for side-loading equipment. Typical loading can be in the area of 120 psi.

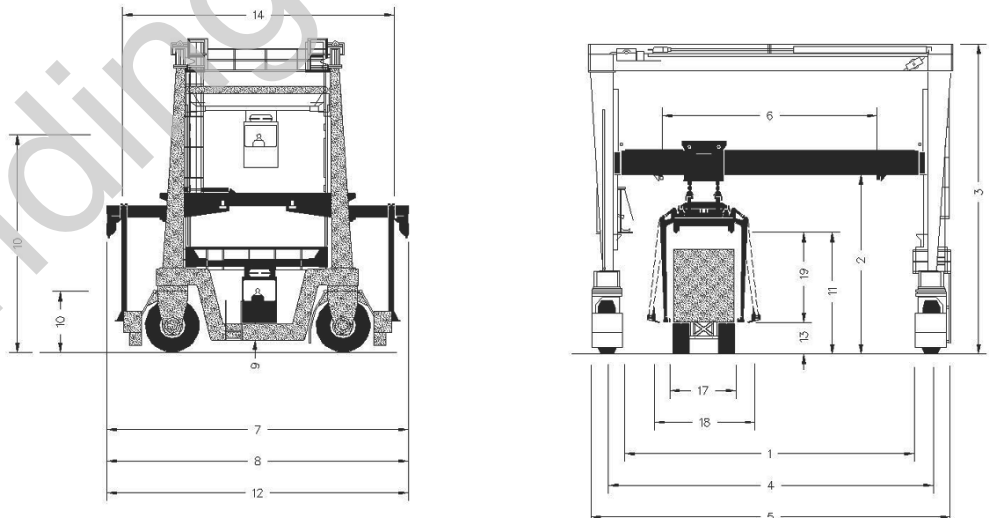


***Figure 14-4-9. Typical Rubber Tired Gantry Crane***

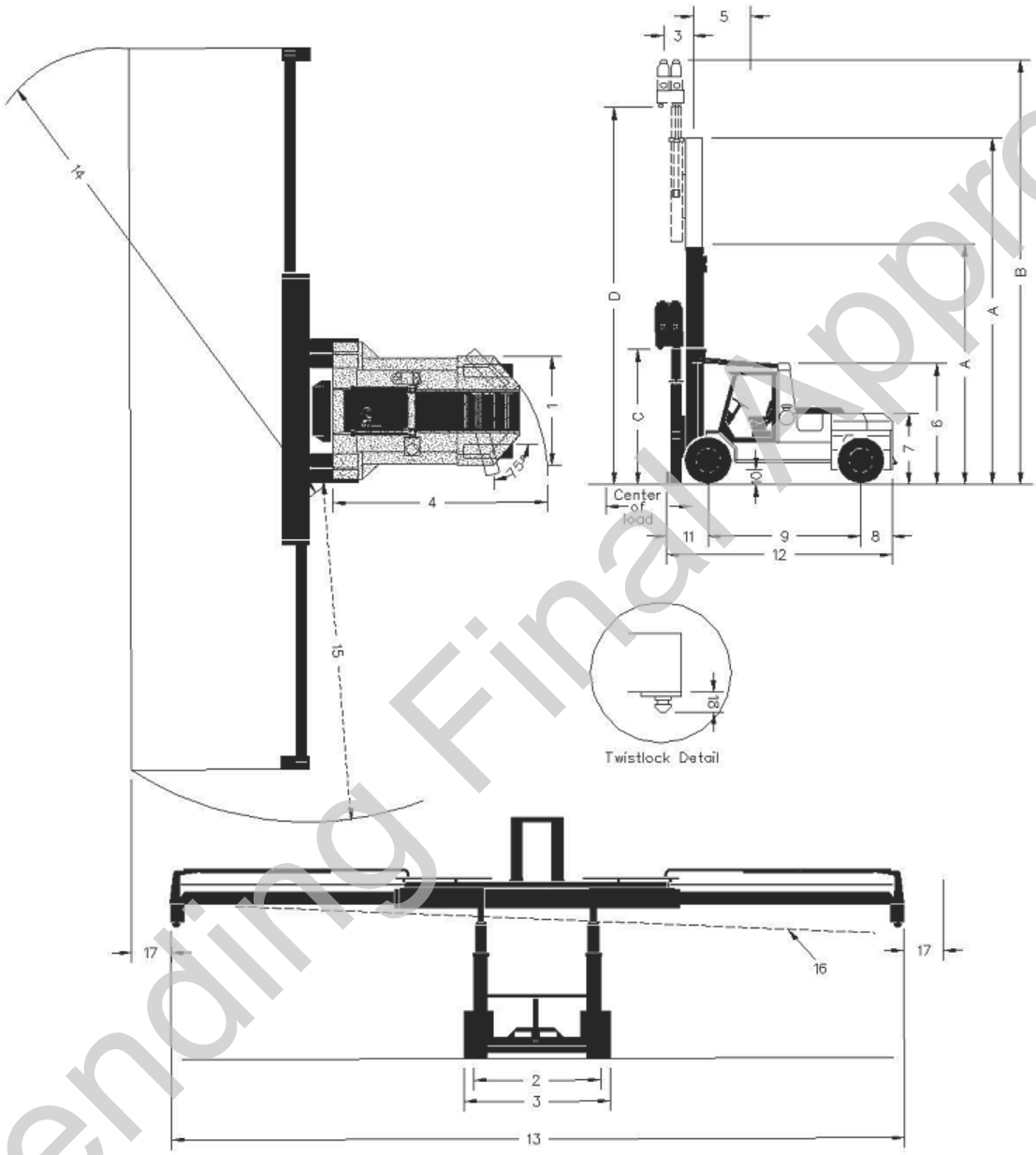


*Figure 14-4-10. Typical Container Handler*

*Table 14-4-1. Range and Average for Reach-Stackers, Side-Lift and Gantry*

| | | Range | Average |
|---|---|---|---|
| **Reach-Stackers** | | | |
| | Wheel Base (ft) | 19.75-25 | 23 |
| | Front Wheel Track (ft) | 10.75-12.5 | 12 |
| | Empty Axle Load (lbs) | | |
| | Drive (Front) | 75,000-131,000 | 102,000 |
| | Steer (Rear) | 56,000-118,000 | 88,000 |
| | Loaded Axle Load (lbs.) | | |
| | Drive (Front) | 220,000-268,000 | 241,500 |
| | Steer (Rear) | 13,800-80,000 | 45,000 |
| | Tire Inflation (psi) | 95-120F/65-120R | 110F/110R |
| | | | |
| **Side-Lift** | | | |
| | Wheel Base (ft) | 18.75-24 | 21.5 |
| | Front Wheel Track (ft) | 12-14 | 13 |
| | Empty Axle Load (lbs) | | |
| | Drive (Front) | 98,000-159,000 | 117,500 |
| | Steer (Rear) | 52,000-55,000 | 53,000 |
| | Loaded Axle Load (lbs.) | | |
| | Drive (Front) | 214,000-286,000 | 237,000 |
| | Steer (Rear) | 15,500-21,000 | 17,500 |
| | Tire Inflation (psi) | 90-120F/65-120R | 110F/100R |
| | | | |
| **Gantry** | | | |
| | Wheel Base (ft) | 20-24 | 21.75 |
| | Wheel Track (ft) | 42.5-65.5 | 50 |
| | Empty Wheel Wt. (lbs) | 37,500-77,500 | 52,000 |
| | Loaded Wheel Wt. (lbs) | 57,500-103,000 | 75,000 |
| | Tire Inflation (psi) | 80-125 | 95 |

(2) Trailer/container storage (loaded or empty)

Pavement loading considerations for trailer storage must address these four questions:

(a) Is the pavement designed for the parking of full semi-trailers?

(b) Will the aisles between the parking rows be accessed only by truck traffic, or will lift equipment also be operating in the area for 'turning' of containers?

(c) Are the chassis (dolly) wheel pads adequate? (Dolly or chassis wheel pads, usually 5-8 feet in width, are subject to much higher concentrated loads. The older style, round steel wheels have significantly higher loadings than do the newer flat-plate style.

(d) Will stacked containers by adequately supported? Stacked container storage (without dollies) will have concentrated loads at the four lock-down pins located about the base of the containers. The concentrated loads at these pins will be higher than most any pavement can withstand, resulting in localized punching until the body of the container is resting upon the ground. The limit of most rail facility loading equipment is a stack 4-containers high. The aisles in stacked container storage must be designed for side-loading lift equipment which can exert very high loads.)

(3) Hostlers vs. Over-the-Road trucks

Though similar in nature, hostlers differ from OTR tractors in the incorporation of a single rear driving axle versus the tandem arrangement employed by OTR's. This will result in higher loads throughout the facility where hostlers are driven.

(4) Chassis storage

Empty chassis are generally stored either as parked trailers or in special racks. Where racks are not employeed, light duty pavements are frequently used.

b. *Pavement Life.* The life of any pavement is comprised of two factors; load cycles and serviceability. Over the life of the pavement, it will support a number of load repetitions at a given severity. Each load will damage, or in effect, wear the pavement. The relationship to load versus frequency is not linear, with a single heavy load causing more wear than several, or even many loads at half the weight. In summary, every pavement fails, the goal is to ensure maximum service life for the least overall cost.

As the pavement wears, it cracks, pumps, shifts, ruts, shells, and otherwise deforms from the original flat, smooth condition that existed when it was constructed. Over the life of the pavement, maintenance measures may be incorporated to correct the damage, or to reduce its advancement. The point at which a pavement is worn or damaged beyond the economic effort to maintain it, thus requiring replacement, is the practical end of its service life. This point is a function of both the level of corrective maintenance applied over the life of the pavement, and the acceptable level of damage over which facility vehicles can be operated.

The terminal serviceability level of the pavement is defined by the facility operator. This is impacted by the level of maintenance that will be performed over the life of the pavement. Assuming the number and severity of load cycles can be calculated, the pavement design can be defined.

From these considerations several conclusions can be deduced:

(1) A facility which will not receive much maintenance over its life due to cost or operational considerations will require a more durable pavement section than one under like conditions which receives regular maintenance.

(2) Temporary or short-term pavements can be employed which have a lower cost of installation, but they will require heavy maintenance or frequent replacement. The ultimate choice of a short term pavement versus long term solution must not only include allowances for changes in area use, but an economic decision of the total cost of the pavement over the total life of the facility.

(3) Though gate facilities which only handle highway traffic experience light loads over their life, the number of load cycles in these areas will be significantly higher as all highway traffic must pass through them. Likewise, aisles and frequently traveled routes will generally require a more durable pavement than parking areas.

(4) The total facility cost of a side-load operation is generally much greater than a gantry only, due to the overall surface area which is subject to side-loading equipment loads. Careful planning must be undertaken to ensure that the limits of pavement designed for side-load equipment closely match the actual operation.

(5) The use of ridged pavements under stacked container storage is not advised as the concentrated loads result in the fracture of the pavement rather than the deformation. Flexible pavements with pockets from loading pins can be healed without replacement.

#### 4.2.3.3.3 Portland Cement Concrete Wearing Surface

a. Gantry crane runway widths vary from 5 to 10 feet. Thickness will depend upon factors referenced in Article 4.2.3.3.2.

b. Concrete pads for semi-trailers landing gear are often necessary. The pads should be at least 5 feet wide and 8 inches thick, but actual dimensions should be governed by soil conditions.

c. The consideration of sub-base layers may be as crucial as the design thickness of the concrete.

d. The use of concrete roadways normally provides the following benefits:

(1) Assures stable, non-erodable, skid-resistant, uniform platform surface.

(2) Increases possible uses of overall platform area as business conditions change, assuming this was taken into account when pavement section was designed.

(3) Historically has longer service life between maintenance cycles if designed properly.

#### 4.2.3.3.4 Asphalt-Concrete Wearing Surface

This paving is frequently used for roadways, trailer/container parking space, and for truck driveway maneuvering areas.

a. Use of asphalt-concrete in the roadways, parking, and maneuvering areas, normally provide the following benefit to the owner or operator of the facility.

(1) Lower initial capital cost

(2) Historically lower maintenance costs per individual failure point

(3) Assures stable, non-erodable, uniform platform design

(4) Facility disruption is minimized during periods of surface repair

b. Use of asphalt-concrete should use maximum design criteria for local DOT or airport design specifications.

c. As in concrete design, consideration should be given to aggregate type (slag, processed miscellaneous base or large crushed aggregate) as non-traditional mixes have shown positive results in many cases. Pavement design procedures link pavement performance to the material's elastic modulus or stiffness, and Poisson's ratio, as well as their performance under load repetitions and environmental changes. These can be summarized in the form of fatigue performance during service for different temperatures.

#### 4.2.3.3.5 Liquid Asphalt Surface Treatment

This type of paving can be constructed where economy in initial capital expenditures is vital, yet a dust-free surface is necessary.

#### 4.2.3.3.6 Waterbound Macadam

This is the least expensive type of paving and can give satisfactory performance at small to medium sized ramp-loading terminals. It can also be used in empty storage areas. After compaction under use, a stronger type of pavement can be overlaid for facility expansion.

#### 4.2.3.3.7 Roller Compacted Concrete

Roller compacted concrete (RCC) is a zero slump concrete mixture that is mixed, placed, and rolled with the same commonly available equipment utilized for asphalt pavement construction. Because of low water content, the mix can have similar or greater strength than conventional Portland concrete cement. Potential problems arise from the fact that few contractors have experience with the process, it tends to unravel over time, and it cracks continuously making it susceptible to water migration, hence freezing and thawing. The attendant unsightly cracking, is usually offensive to management.

#### 4.2.3.3.8 Pavers

The use of pavers has had limited use in the U.S. and has been tried at a few port facilities. They are reputed to provide a highly durable surface, while tending to perform in a manner of flexible pavements.

#### 4.2.3.3.9 Unbound Granular Materials

Granular materials consist of gravel or crushed rock that have a gradation which makes them stable and workable. Recycled concrete and/or asphalt should not be overlooked as an excellent base material. Dust control and surface maintenance is an accepted liability with the use of this product.

#### 4.2.3.3.10 Cement Treated Materials

Cement treated materials are produced by adding a sufficient amount of cement to the granular materials or soil to create a bounded layer with higher stiffness and strength than unbound materials. The layer should not be so thin that it cracks under load, thereby permitting pumping of underlying soils if water is present.

#### 4.2.3.3.11 Specifications and Construction Procedures

Individual state department of transportation standard specifications can be used with airport pavement and drainage specifications for constructing the pavement and drainage systems. In most circumstances, ASTM tests are still the standard testing benchmark for soil and materials testing.

#### 4.2.3.3.12 Soil Treatments

Existing soils play a major role in their potential to influence the type and cost of surface material used on a given site. Certain fundamental treatments applied to soils have shown to be successful.

a. Lime/Flyash: Incorporated into certain soil types, it can lower the Plasticity Index and actually strengthen the soil. It will leach out and lose strength if not under a water repellant wearing surface.

b. Cement can:

(1) Provide an impermeable, uniform, support for the pavement.

(2) Eliminate subbase consolidation.

(3) Improve load transfer at joints.

(4) Expedite construction since it stabilizes the working base during adverse weather.

(5) Provide firm support for slipform paver or side forms.

(6) Be cost competitive over granular materials in certain areas.

(7) Increase strength of substandard granular materials.

c. Geo-Webs: Consolidate granular material in confined spaces, bridges sub-standard soil support conditions.

d. Geo-Grids: Combined with layers of granular materials and/or select fill, can bridge substandard soil conditions.

e. Fabrics: See Geo-Grids.

In summary, the sensitivity of subgrade strength to moisture content should be assessed in detail. In general the following rules apply:

a. For sandy soils, small fluctuations in moisture content produce little change in stiffness/strength or in volume,

b. For silty soils, small fluctuations in moisture content produce little change in volume, but can produce large changes in stiffness/strength,

c. For clay soils, small fluctuations in moisture content may produce large changes in volume and in stiffness/strength characteristics.

#### 4.2.3.3.13 Drainage Structures

Drainage structures can be of most varieties, but must be able to withstand the loading of lift equipment. Generally, those grates and drainage structures approved for airport use are readily applied to intermodal facilities.

#### 4.2.3.4 Parking

Parking facilities should be near the loading tracks with additional parking for storage, as required.

#### 4.2.3.4.1 Trailers

a. Yard and road tractors are the primary method of moving trailers within a terminal. The trailer parking configuration shown in Figure 14-4-1, Figure 14-4-2, Figure 14-4-3, Figure 14-4-5, and Figure 14-4-6 should be adequate to accommodate the daily traffic in each type yard. A 10-by-50-foot parking area should be provided as a minimum for each trailer. Additional length may be desirable to avoid having 53 feet units encroach upon aisleways. Wider slots may make maneuvering easier but does so at a significant loss in the total number of parking slots that can be provided on a given piece of land.

b. A trailer parking area of approximately two-and-one-half times the number of trailers handled each day should be planned. This ratio is based on historical trailer dwell periods experienced at intermodal terminals. The amount of parking necessary may vary widely for terminals that primarily serve a single customer, such as a marine terminal, the U.S. Postal Service or UPS.

#### 4.2.3.4.2 Containers

a. A crane is used to move the container from the chassis or flat bed pulled by a yard tractor. Alternatively, the containers can be left on the chassis. A large number of containers are loaded or unloaded at marine terminals in a short period of time and the storage-yard capacity will control operational efficiency.

b. There are three basic configurations for parking/stacking the containers.

#### 4.2.3.4.2.1 Herringbone Layouts

Used to store containers either on chassis or on support legs, with no stacking.

#### 4.2.3.4.2.2 Block Layouts

The best use of scarce parking areas; containers are stacked three or four high in a tight block. Block layouts are often used for storing empty containers and for long-term storage of containers awaiting outbound movements.

#### 4.2.3.4.2.3 Ribbon Layouts

Offer better container selectivity than block layouts.

**NOTE:** For further information and typical design drawings on container terminals, refer to the report of Committee 14, Assignments entitled "Terminal Facilities for Container Handling," in Bulletin No. 635, Proceedings Volume 73, Nov. - Dec. 1971.

### 4.2.3.5 Security

TOFC/COFC facilities are easy targets for both organized and random burglary. Further, the terminals are often in high-crime environments where theft operations can be highly organized. Security for TOFC/COFC facilities is therefore essential. Security measures include fencing, lighting, guards and patrols, closed circuit TV to scan the terminal and sensor systems.

### 4.2.3.6 Facility Services

#### 4.2.3.6.1 Electrical

a. Lighting and power outlets in the track area may be provided to assist tie-down operations. Parking areas should be lighted if there are extensive night operations or for security and safety reasons.

b. Typical design procedures and criteria are published in the Illuminating Engineering Society's IES Lighting Handbook.

#### 4.2.3.6.2 Communications

Communication facilities within and beyond the operation area should be provided for efficiency. In addition to traditional phone systems and two-way radios, modern communications systems include computer-in-cab systems for both cranes and yard hostlers, radio frequency automatic equipment identification systems, and localized geopositioning systems.

#### 4.2.3.6.3 Utilities

Underground utilities are desirable to avoid conflict with operation. Sanitary, water, HVAC, electrical utilities and possibly engine block heaters should be provided in accordance with the facility requirements. Fire Protection should be provided as stipulated in Part 1, Generalities, Section 1.6, Fire Prevention in Yards.

#### 4.2.3.6.4 Grading and Drainage

a. A typical drainage system layout usually consists of a trunk line parallel to the tracks with lateral lines running under the tracks at about 200 to 300 feet intervals with catch basins between each track. Inlets should be located at all gutter low points and at any planned low points in parking areas. Other methods use trench drains between the track and pavement sections, or slotted drains in large paved areas.

b. Local, state, or national agencies may have drainage-design requirements and may specify certain design procedures. In the absence of any jurisdictional agency, county or state highway department procedures are suggested for use.

c. It is imperative to follow good engineering practice in all elements of design and construction, including preparing and compacting of the subgrade, increasing the bearing capacity of soils as necessary, erosion protection, proper sloping of cuts and fills and surface and subsurface drainage systems.

d. Care should be taken with the design of drainage systems where containers are staged or stored in grounded stacks. Where possible drainage should be directed away from these areas. Other methods include providing slightly raised concrete pads to support containers on their corner castings, allowing a few inches of space under the body of the container for the passage of surface water.

#### 4.2.3.6.5 Water Pollution Control

Water pollution control ranging from oil/water separators to full treatment and pH balancing may be required at the following service areas:

- Fuel.
- Maintenance Building.
- Outside Maintenance Areas.
- Trailer and Truck Washing Facilities.
- Paved Parking Areas.

#### 4.2.3.6.6 Truck Scale

A truck scale meeting state highway specifications may be needed to check the weight of loaded trailers. When required, it should be installed in the facility entrance/exit area. See AAR Scale Handbook included in this manual for details.

### 4.2.3.7 Terminal Buildings

Complete design criteria available in Chapter 6, Buildings and Support Facilities. However, for information note the following:

#### 4.2.3.7.1 Offices

The larger-volume operations will require an office for supervisory and clerical staff, with the normal amenities for operating personnel. Standard office design criteria should be used, including provisions for communications, uninterruptable power supply and employee parking.

#### 4.2.3.7.2 Storage Building

A storage building should be provided for blocking and bracing material for adjusting shifted loads.

#### 4.2.3.7.3 Air Compressor Facilities

Air compressor facilities are required for making brake tests on cars and for the use of air tools.

#### 4.2.3.7.4 Interior Washing Facilities

Interior washing facilities and appurtenances may be necessary if refrigerator trailers are handled in sufficient quantity.

#### 4.2.3.7.5 Container Transloading Building

A container transloading building may be required.

#### 4.2.3.7.6 Guard Building

a. When the office is not located at the entrance, a separate guard building should be provided for check-in and check-out and equipment condition inspection. If not provided elsewhere, the guard building may also be used to support security activities and provide for outside communication.

b. There are several methods of making trailer/container roof inspections when required.

   (1) Overhead mirrors;

   (2) High platforms with ladders or stairways; and

   (3) TV cameras monitoring from the interior of the office building.

#### 4.2.3.7.7 Transfer and Customs Inspection Dock

A transfer and customs inspection dock may be provided for transferring loads from damaged trailers and for making customs inspections.

#### 4.2.3.7.8 Gate Check-in Facilities

High volume facilities require efficiently functioning gates to maintain a smooth flow of vehicles into and out of the terminal. Special lanes may be provided for bob-tail tractors. Telephone pre-check stations allow drivers to give clerks all necessary information before they proceed to scales and inspection stations. By executing a pre-check, an interchange document can be printed at the inspection station before the driver arrives.

#### 4.2.3.7.9 Hazardous Material Containment

A special area of the terminal may need to be set aside where hazardous material can be contained if a leaking container or trailer is encountered.

### 4.2.3.8 Maintenance and Service Buildings and Facilities

#### 4.2.3.8.1 Locomotive and Car Maintenance

a. Maintenance operations for locomotives and cars at TOFC/COFC facilities are usually done at nearby service facilities.

b. Much of the maintenance of both freight cars and locomotives is closely regulated by either the FRA or the AAR, and it is important to consider their repair procedures in designing a maintenance facility. EPA and state environmental agency requirements must also be considered. Car repair at a TOFC/COFC facility normally includes light repair performed in the yard, however with the intense use of double-stack container cars, heavier repairs such as wheel changeouts are also undertaken while the car is in the terminal rather than sending it to a shop location for this work.

#### 4.2.3.8.2 Trailer/Container and Tractor Maintenance and Servicing

a. The corner-post securing devices (for containers) and the fifth wheel/trailer securing devices must be periodically checked to ensure the devices are secure. In the case of refrigerated units, diesel-powered generators must be checked. Tractor maintenance and service may be provided when necessary.

b. Other repairs that may be accommodated at an intermodal facility include:

(1) Watertightness repairs to trailers and containers.

(2) Tire repairs to hostlers, trailers and chassis.

(3) Lamp and lens replacement for chassis and trailers.

#### 4.2.3.8.3 Equipment Fueling Facility

Fueling facilities for equipment should be considered. The equipment requiring fueling facilities are:

a. Tractors.

b. Refrigerated Trailers.

c. Gantry Cranes.

d. Side Loaders.

e. Portable Generators.

f. Straddle Cranes.

g. Other Mechanical Equipment.

#### 4.2.3.8.4 Side-Loader/Crane Maintenance Facility

a. A separate building will improve maintenance of this equipment, especially in colder climates.

b. Complete design criteria and additional pertinent information are readily available in Bulletin 696, Proceedings Volume 85, May 1984, pages 157-190.

## SECTION 4.3 AUTOMOBILE AND TRUCK LOADING/UNLOADING FACILITIES

## 4.3.1 AUTOMOBILE LOADING/UNLOADING (1993)

### 4.3.1.1 General

a. The transfer of automobiles to and/or from rail cars (i.e. rail-truck, rail-rail, truck-rail, ground-rail or rail-ground) generally requires a separate facility to accomplish this task. This separation is required to insure protection and security of the automobiles.

b. Domestically-produced automobiles are frequently loaded on rail cars within the confines of the manufacturing plant. Foreign-produced automobiles are usually loaded on rail cars at dock-side. Many transfer variations can be utilized; however, in each case, securing the operation is of prime concern. This type of facility may also be used for automobile ferry services.

c. Items to be considered in selecting an automobile loading/unloading (transfer) facility are as follows.

#### 4.3.1.1.1 Location

A site should be selected with easy access to main highways, as well as ease of rail switching. Consideration should also be given to the potential of vandalism so as to avoid missile damage and theft. Proximity to areas that may generate air pollution which could damage automobile finishes should also be examined. It is also desirable to not locate in low lying areas to avoid potential flood damage to vehicles.

#### 4.3.1.1.2 Size

a. The size of the facility, its trackage, ramping and vehicle storage areas, should be large enough to handle the maximum expected load under the proposed operating conditions. Some of the conditions to be considered are: the average work week, type and quantity of vehicles handled and the number of agencies using the same facilities. The auto production and distribution process, by its very nature, requires a considerable degree of advance planning, including volume predictions. All auto manufacturers can and do make rather good volume predictions which can be utilized for planning purposes. Future needs should also be evaluated if possible.

b. Factors which affect the sizing of an unloading facility are:

   (1) *Automobile Parking.* Requires estimate of maximum number of vehicles in facility at one time.

   (2) *Truck Transport Area.* The number of truck transport loading stalls must be determined.

   (3) *Track Capacity.* Adequate multilevel rail car capacity should be provided to allow one switch or spot per shift.

   (4) *Rain Runoff Retention Ponds*. Consideration should be given to retaining runoff from the large paved areas to prevent flood damage to adjoining properties.

   (5) *Buildings.* Office space, washrooms and locker facilities should be determined. Cleanliness of employees handling automobiles is important to prevent soiling of vehicles. Office buildings or servicing facilities for haul-away trucks may be necessary. However, separation of these facilities from the primary automobile area is desirable to maintain automobile security.

   (6) *Employee/Visitor Parking*. Consideration should be given to providing a separate secured parking area.

   (7) *Miscellaneous*. Dead battery parking, damaged vehicle parking, specialized vehicle handling requirements (i.e. van, truck, luxury and military).

#### 4.3.1.1.3 Security

Since the vehicles are left with the keys in them, security is of prime importance. The entire area should be fenced to discourage unauthorized entry and theft. Many facilities are arranged so that automobiles can only be driven out of the parking area over haul-away docks or ramps. Provisions for checking employees and visitors in and out should be made. Parking stalls should be away from security fence to provide an unobstructed buffer area around inside of fence. Other electronic security devices can also be utilized. (See Article 4.3.5.)

#### 4.3.1.1.4 Lighting

Lights should be provided for entire area adequate for security and for loading, unloading and inspection, if required. Poles should not be located in fence line. (See Article 4.3.5.)

#### 4.3.1.1.5 Zoning, Building Codes and Permit Requirements

All Local, State and Federal requirements must be met. Considerable time may be required to obtain some Permits.

#### 4.3.1.1.6 Special Requirements

Customers' needs or standards should be evaluated.

### 4.3.1.2 Design Considerations

#### 4.3.1.2.1 Parking

Layout configurations vary from facility to facility. Most patterns are determined by the overall size and shape of the land available. Four patterns of parking are available. They are 90 degrees head to head, angle parking-head to head or angle (herringbone) pattern. Parallel line parking, head to tail, is sometimes utilized for direct loading. The advantages or disadvantages of each must be addressed for each facility.

a. Typical Configurations (right angle parking-head to head). See Site Plan Example - Figure 14-4-11.

   (1) Stalls:

   - Standard - 10′ ξ 20′.
   - Luxury or Van - 10′ ξ 22′.
   - Dead Battery - 11′ ξ 20′.
   - Damaged Vehicles - 12′ ξ 22′.
   - Clearance from security fence - minimum 10 feet.

   (2) Aisles:

   - Between Stalls, One Way - minimum 22 feet.
   - Main Trafficways, Two Way - minimum 30 feet.

   (3) Number of stalls:

   - Approximately 125 vehicles per acre with 10′ ξ 20′ stalls.

b. Surface Asphalt Paving Recommended:

   - Many facilities are built with 4 inch asphalt thickness made up of 2-1/2 inch base course and 1-1/2 inch surface course on a suitable soil or rock subbase.
   - However, pavement design, including subbase, should be based on local design considerations with asphalt thickness consistent with site conditions.

c. Grades.

   (1) Grade:

   - As near level as practicable but with sufficient slope to promote drainage.

   (2) Sub-Grade:

   - Consistent with local conditions and adequate to support automobile loading.

d. Row and Stall Identification.

(1) Striping recommended for parking stalls and lanes. Direction arrows may also be desirable.

(2) Rows designated with Capital Letters:

- Desirable to locate row letters on signs (12-inch high letters) at end of rows, minimum 8 feet to bottom of sign.

(3) Stalls numbered with numbers placed on left near aisle.

e. Staging Area - Bumper to bumper staging (aisles 9 feet - 12 feet wide) may be used for common destination movements.

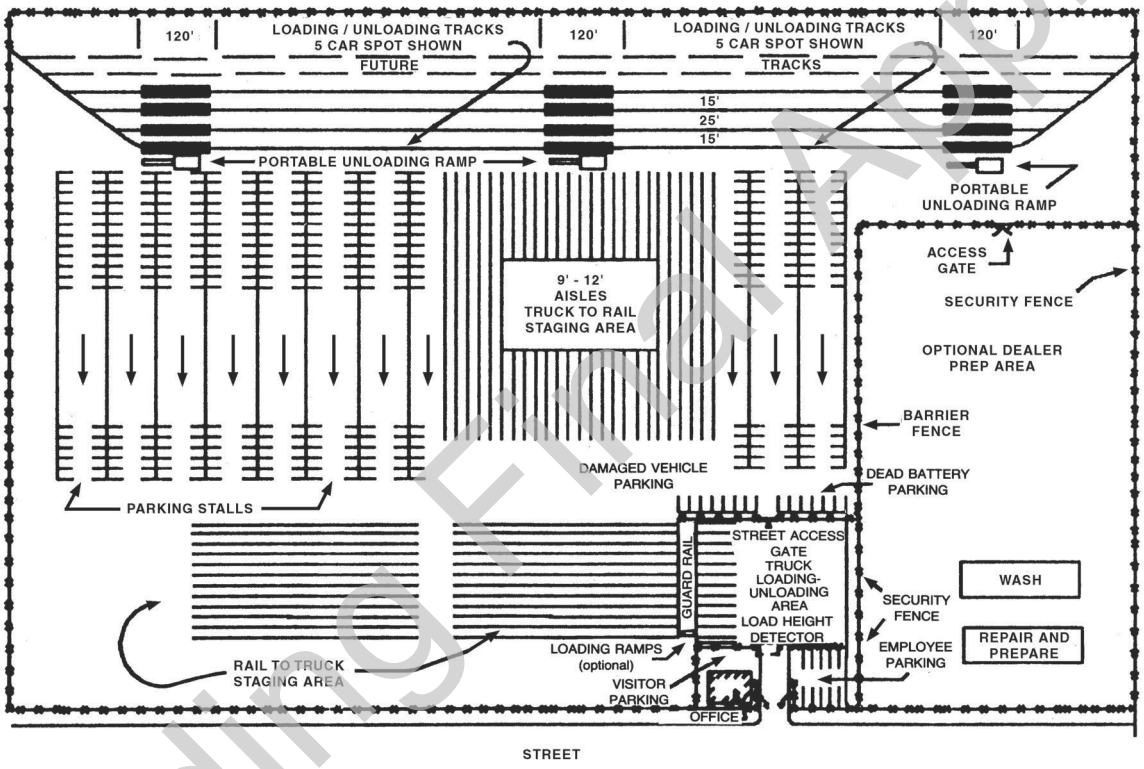


*Figure 14-4-11. Automobile Loading/Unloading Site Example*

#### 4.3.1.2.2 Track

a. Grade. As near level as practicable.

b. Centers.

(1) 15 feet minimum.

(2) 25 feet or more where service vehicles drive between rail cars and for placement of bridge plate storage racks.

c. Structure.

(1) Open (unpaved).

(a) Advantages.

1 Ease of maintenance.

2 Easier drainage if ballast above pavement.

(b) Disadvantages.

1 Requires crossings and/or unloading areas every four to six car lengths and unloading configuration is fixed.

2 Ballast must be kept out of roadways.

(2) Paved.

(a) Advantages.

1 Can spot rail cars for unloading from either end in any grouping (from one to six cars).

2 Less restricted driving when tracks unoccupied.

(b) Disadvantages.

1 Track maintenance difficult.

2 Requires sub-drainage.

3 Additional cost.

d. Lengths.

(1) All (un)loading tracks same capacity if possible for uniformity of switching (approximately 95 track feet required for typical rail car).

(2) Multiple of four to six car segments with paved (or planked) unloading area (120 feet minimum length) at each end and between each four to six car segments.

(3) Tangent track required for each multiple rail car spot.

e. Turnouts.

(1) Unpaved for ease of maintenance.

(2) Recessed switch stands where high switch stands might be struck by vehicles.

f. Limits for Rail Car Spotting.

(1) Stripe in paved areas.

(2) Steel bumping posts with heavy impact break-away design.

(3) Wheel stops placed for cars with least end overhang.

(4) Concrete dock with wood or mechanical bumper at coupler level.

g. Other Features.

(1) Auxiliary trackage.

(a) Secondary rail car storage tracks may be necessary, depending on volume of automobile shipments.

(b) Additional tracks may also be needed for rail car inspections and/or repairs prior to loading.

(2) Bridge plate storage racks.

(a) Serve two adjacent tracks.

(b) Should be opposite car couplers.

(c) Can also serve as mounts for fee extinguishers.

(d) Paint bright color to inhibit vehicles striking.

(3) Protection of (un)loading personnel.

(a) Provide Blue Flag protection at entry ends of all (un)loading tracks with rack for unused flag storage.

(b) Provide private locks on entry switches, derails and/or gates.

(c) Provide audible rotating light alarms on rail entry gates.

#### 4.3.1.2.3 Rail Car Loading/Unloading Equipment

a. Should be designed to allow quick drive on/off of automobiles. Automobile manufacturers should be consulted to determine maximum permissible ramp angles.

b. Typically self-propelled, rubber-tired, ramps used which can be raised and lowered to reach the three levels of a standard rail car.

c. Consideration should be given to provide concrete pavement or planked crossing surface at loading/unloading area under portable ramp since area is heavily travelled, has frequent twisting of wheels and is exposed to hydraulic oil and gasoline leaks.

d. Track or rail-mounted ramps used at same locations either from ground level or on elevated dock.

#### 4.3.1.2.4 Transport Truck Loading/Unloading Area

a. The truck haul of automobiles is normally handled by a separate company or contractor. There are many variations of transport trucks in existence. It is important to verify transport truck dimensions before designing this area.

b. Provide sufficient space to permit turning and spotting of truck for loading/unloading of automobiles.

c. Volume predictions required to determine number of transport truck spaces. Stalls normally 12 feet wide.

d. Consider use of concrete pavement for durability.

e. Provide physical separation of area from automobile parking-staging area for security. Fence and/or low guard rail normally used. Guard rail must be low enough to allow placement of ramps over rail and high enough to prevent driving automobiles over the rail. Verify transport truck dimensions.

f. Ground mounted, adjustable, steel ramps sometimes required to load some types of transport trucks.

## 4.3.2 TRUCK CHASSIS LOADING/UNLOADING (1989)

### 4.3.2.1 General

Factors regarding location, size, buildings, surfacing, security and lighting enumerated above for automobiles apply equally as well to truck chassis. The rail equipment and the placement of the trucks on the rail equipment differs. Trucks with cabs, but without bodies (truck chassis) are commonly shipped in "saddleback" fashion on a specially equipped flat car. Thus, the use of a crane is required for loading and unloading. While the loading may be done at a plant site exclusively devoted to trucks, the unloading operation can conveniently be incorporated into and made a part of a typical automobile unloading facility.

### 4.3.2.2 Unloading Track

Truck shipping volumes being considerably less than autos, a single truck set apart from, but adjacent to, auto facilities should suffice. Volume and economic considerations will dictate the degree of separation from, and/or incorporation within, auto facilities.

### 4.3.2.3 Unloading Facilities

Trucks loaded in "saddleback" fashion must be removed from the truck they have been set upon and secured to for transport to a level position on the car deck before being started and driven from the car. The job can be accomplished by a mobile crane of sufficient capacity operated adjacent to the rail car where volume is light and the need only occasional. Where volumes require a greater degree of specialization, it is recommended that an "A" frame crane, track-mounted and electrically operated with running rails located outside of regular track rails, be provided. The "A" frame straddles the car to be unloaded and can be positioned to handle any car spotted within its reach. Figure 14-4-12 details a tie layout to accommodate the "A" frame. Access to the unloading track for pre-starting service should be given consideration. Air supply sufficient to release truck brakes is a necessity.

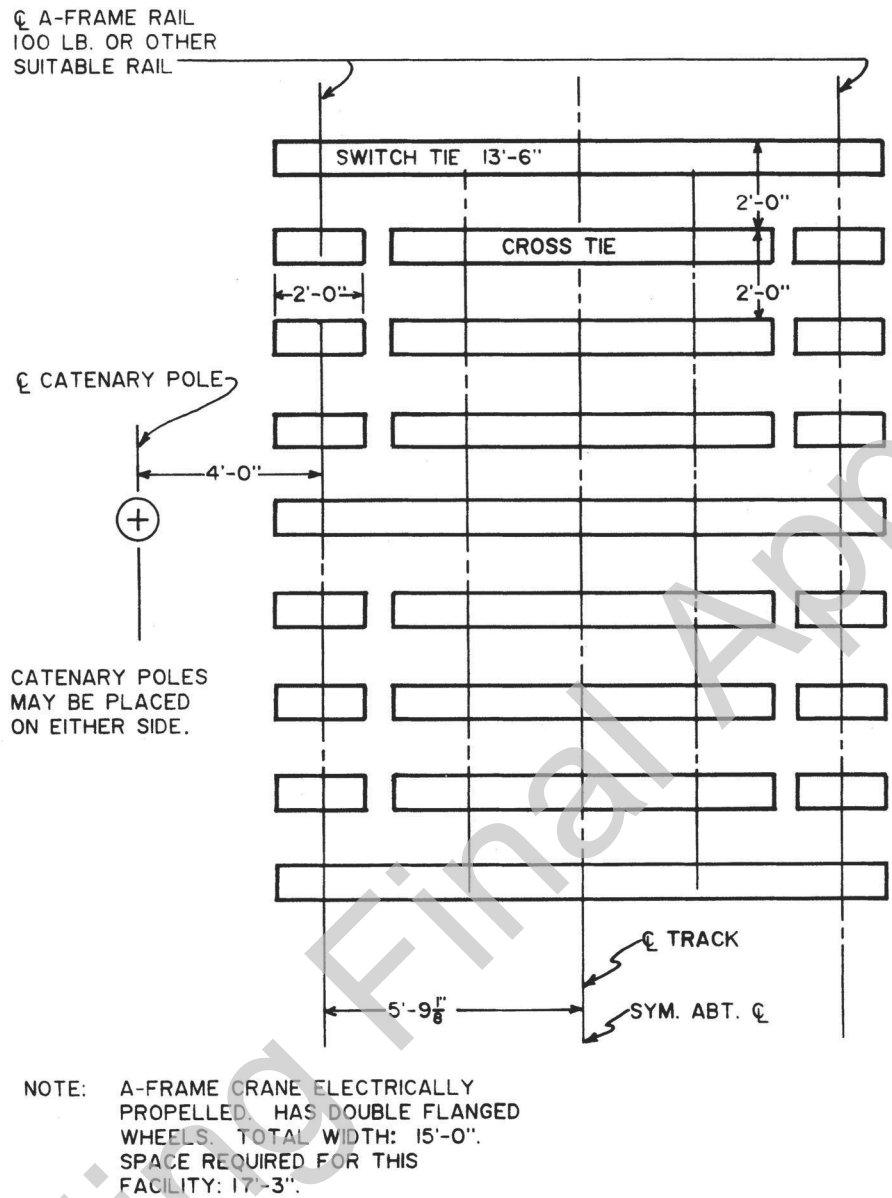


*Figure 14-4-12. Typical Layout or "A" Frame Truck Unloading*

## 4.3.3 MILITARY VEHICLES (1989)

This type of facility may also be used for receipt and transfer of new military vehicles. Special provisions may be necessary to handle some of these vehicles due to weight, size or other considerations.

## 4.3.4 CONTAINERIZED SHIPPING (1989)

Some new automobile shipments are also being moved in standardized containers or enclosed trailers. These shipments can be moved directly from loading point to the dealer's site without actually handling the automobile while in transit. A TOFC-COFC facility is more appropriate for these types of shipments rather than the above-noted configurations.

## 4.3.5 SECURITY (1996)

### 4.3.5.1 Introduction

Rail served auto terminals are specialized facilities designed to transfer autos, trucks, and other vehicles to and from rail cars. Their designs are as unique or individualized as the companies that construct and operate them. The design criterion, however unique, has a common denominator, security. Security not only protects the customer's commodity, but provides a safe working environment for all employees. Security can be enhanced through various methods, including lighting, fencing, barriers, gates, alarms, closed circuit television, card access systems, signs, security guards, or through any combination of these methods.

### 4.3.5.2 General

The level of security commitment can be a direct result of facility design or operational concept. It is also influenced by citing environmental demands, local building codes, capital commitment, volume of traffic, history of thefts or vandalism in area, and combined day/night operation.

### 4.3.5.3 Influence of Operational Concept

a. Currently there are two major methods utilized by the trucking companies that pick up and deliver vehicles to the facility:

- standard or end loading (Figure 14-4-13).
- perimeter loading (Figure 14-4-14).

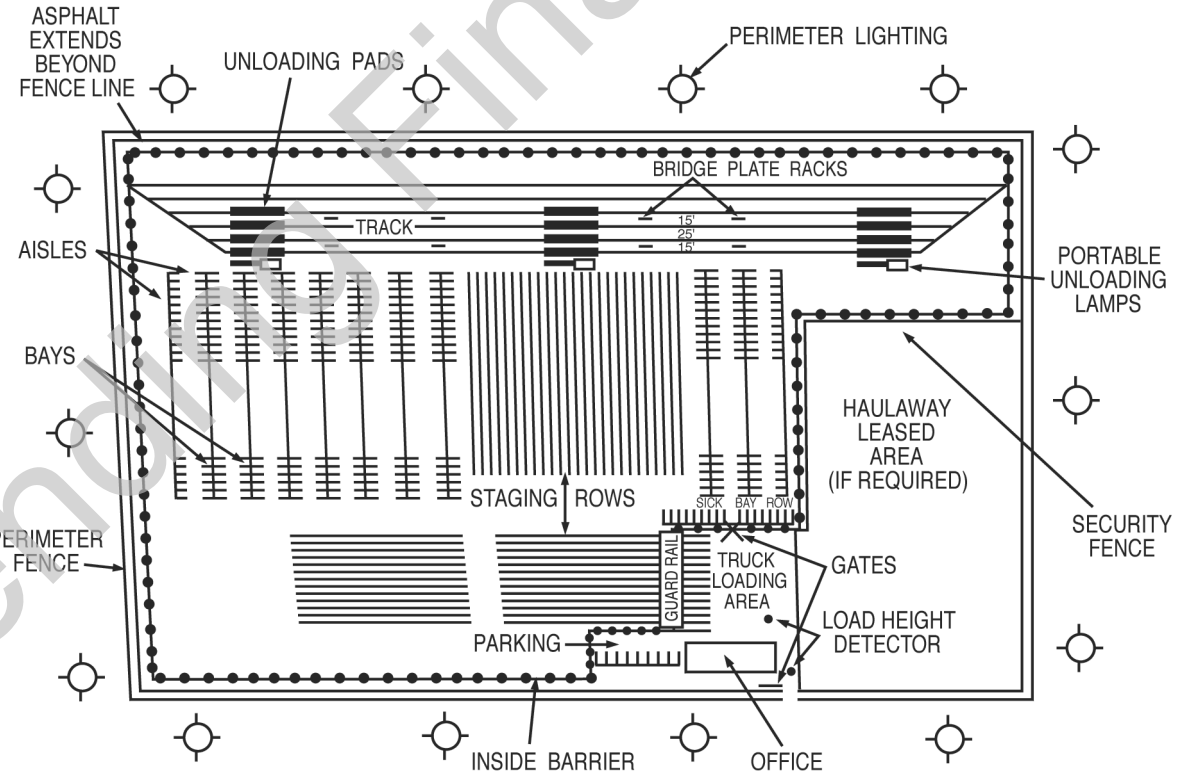


*Figure 14-4-13. Suggested Automotive Handling Facility (Standard or End Loading)*

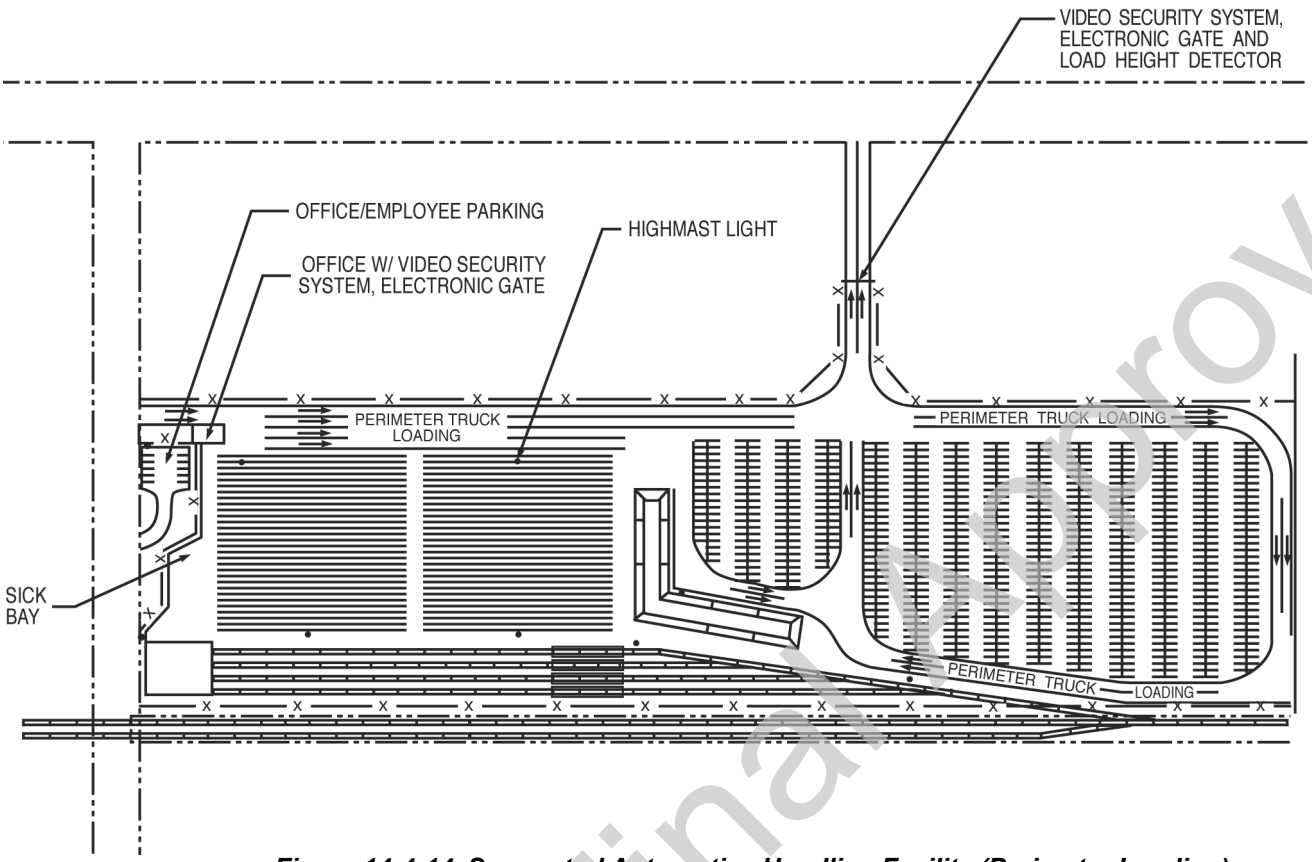


***Figure 14-4-14. Suggested Automotive Handling Facility (Perimeter Loading)***

b. Trucks that use end loading never actually enter the vehicle baying or rail car areas. They back their truck up to a fixed barrier, which should be part of the perimeter barrier, drop their ramps over the barrier, and load or unload vehicles onto or from their trucks. Fixed ramps are also utilized in the same manner. This method ensures that the integrity of the vehicle storage area is maintained. No trucks are permitted in the vehicle baying area.

c. Although originally end loading was the standard for most auto facilities, this method is rapidly giving way to perimeter loading due to perceived operational efficiencies of the latter. Trucks using the perimeter system actually enter the vehicle storage area, and as a result, security demands are increased due to the required monitoring of the additional vehicles and personnel in the storage area. This monitoring may require security guards and/or electronic card reader systems. Exit and entry gate design, as well as camera systems, are influenced by this additional liability.

### 4.3.5.4 Physical Design Criteria

#### 4.3.5.4.1 Lighting

a. Proper lighting provides a safe working environment for employees and customers. It helps prevent theft and vandalism of a shipper's product by enhancing the power of the human or electronic observer. It can also act as an effective psychological deterrent.

b. At this time, high pressure sodium lighting has proven to be the most efficient and cost effective in security applications. It provides more than twice the illumination of a standard mercury vapor light. Depending on the size and shape of the facility, 200, 400, and 1,000 watt high pressure sodium lights should be considered. Every effort should be made to maintain a minimum of 1 foot candles throughout the facility, with an average of 1.5 feet candles.

c. Additional localized lighting will be required for facilities with camera monitoring or where truck loading, or other operations, is prevalent at night.

d. All light poles should be located as far from the perimeter fence as possible.

#### 4.3.5.4.2 Perimeter Barriers

a. Perimeter barriers prevent the unauthorized removal of vehicles from the facility. The barrier should be within or a part of the perimeter fencing and completely encompass the interior except those areas protected by gates.

b. Barrier types include scrap rail, standard highway barriers, pipe, horizontal rails in fences, bollards cable, and concrete.

c. Barriers should be of a sufficient strength and planted to a depth as to withstand a direct impact by a vehicle.

d. In facilities using an end loading or standard concept, barriers in the loading/unloading area should be just low enough to allow truck ramps to clear.

#### 4.3.5.4.3 Fencing (or Walls)

a. Proper fencing can prevent the unauthorized entry of persons onto a facility. A fence or wall should completely surround the facility with exit/entry gates incorporated into the system.

b. Chain link fence is one of the most cost efficient and effective types of fence. Fencing should consist of galvanized steel fabric with horizontal rails and tension wires. Fabric should be at least #9 gage hot dip galvanized per ASTM A-392, Class 1, 2-inch mesh. Minimum height of fabric should be 8 feet. Tension wires, top and bottom, should be #7 gage and conform to ASTM A-824. Posts should be steel pipe per ASTM A-120. Fence should be constructed in a manner that will not allow deformation to occur. Considerations for maximum fence strength include diameter of posts, depth planted, bracing, post spacing, fabric tension, and concrete footings.

c. Regardless of fence or wall type, the addition of barbed wire should be considered to compliment the structure. Wire should be attached to a V or 1/2 V rake, placed on every pole or no less than every 10 feet. There should be a minimum of three strands of wire per leg of V.

d. In high crime areas razor ribbon or concertina wire should be considered in addition to the barbed wire strands.

#### 4.3.5.4.4 Gates

a. Gates should be designed to prohibit the entrance or exit of unauthorized vehicles and persons, and to control the traffic flow of trucks entering and exiting the facility. Gates are also used to control the entrance and exit of locomotives and rail cars.

b. Gates can be constructed from iron, tubular steel, flat steel, and chain link. They should be at least as high as the perimeter fence. The structural integrity should be reinforced and greater than the fence alone. They can be opened and shut by swinging, sliding, or rolling up. Drop bars should be solid steel. All gate hinges should be tack welded to gate posts to prevent gates from being lifted off.

c. Electronically controlled, motorized gates can be activated on site, from a remote location, or self activating underground wire using loops and a card reader system. A telephone or intercom will be required at the gate if it is monitored from a remote site. Gate stability is a primary concern if the facility has a fence alarm system.

#### 4.3.5.4.5 Tire Spikes

a. Depressible spikes can be used at gate areas to control traffic flow and prevent unauthorized exit of vehicles from the facility. They should be well signed and considered a secondary system.

b. Heavy snow and ice may interfere with the operation of these units and available heating systems may be required, along with appropriate drainage to carry off melted snow and ice.

#### 4.3.5.4.6 Fence Alarm Systems

a. Fence alarm systems detect the presence of a person or device against the fence. They sound an alarm, either audible, silent, or both when someone tries to climb, cut or jack up the fence.

b. These systems use point or line sensors, or fiber optic strands to discern impact. A circuit of electricity or light passing through the sensor or fiber is altered when the fence material deflects or breaks. A processing unit is required to respond to circuit changes and signal an alarm, either locally or to a remote location, via telephone modem.

c. The system should be installed in zones, the number of which to be determined by the size of the facility.

d. Terrain, environmental, and weather conditions should be taken into account when considering such a system.

#### 4.3.5.4.7 Closed Circuit Television

A closed circuit television system acts as both a deterrent to theft and vandalism, and as a means of obtaining an accurate record for the investigation of criminal cases. They can be positioned for total or partial coverage of the facility. They can also work in conjunction with the gates, running continuously or activated only when the gates are utilized. Cameras should be capable of recording in color, onto a VCR recorder. The use of color cameras will require additional lighting, up to 10 feet candles.

#### 4.3.5.4.8 Card Access Systems

a. A card access system is an effective method of monitoring or maintaining an inventory of all persons entering and leaving an auto facility.

b. Authorized persons are issued preassigned cards in advance. Upon entering or departing the facility, they activate the gate/card system with their cards. The monitoring/gate access decision making can be performed on site or from a remote location using a computer and phone modem. It is tied directly to the gates, authorizing and monitoring their functions.

c. The card access system consists of cards, card readers, processing controller, software, and a computer. Each card reader may contain its own microprocessor that permits memory and decision making at individually secured gates and doors. It should also include a battery backup system for use in the event of a power failure.

d. The card access system can be tied electronically to the fence alarm system, monitoring both functions.

#### 4.3.5.4.9 Signs

a. Signs placed around the perimeter of the facility can deter trespassing. When placed within the facility they are beneficial in controlling traffic flow.

b. They should be located as not to obstruct the view of the drivers and other personnel. For easy recognition, they should be constructed in a manner similar to those recommended by the Manual of Uniform Traffic Control Devices. Preferably, signs should be made of aluminum with a reflective backing.

### 4.3.5.5 Buildings and Employee Accommodations

Accommodations should be provided for security guards if applicable. Parking for employees should be provided in a separate, secured area.

#### 4.3.5.6 General Comments

a. A maintenance and system testing schedule for all electronic equipment should be developed and followed.

b. Emergency stand-by generators should be considered. This system will provide power for lighting, card readers, gates and/or the perimeter detection system if desired. It should be actuated automatically upon its sensing the loss of commercial external power to the facility.

## SECTION 4.4 BULK-SOLID

### 4.4.1 GRAIN ELEVATORS (2015)

#### 4.4.1.1 General

a. Track facilities to serve large grain elevators involve special yard design. Cooperation between the elevator's engineer and the railway engineer is essential to the development of a satisfactory plan.

b. The location of elevator site, type and capacity of elevator, topography and local conditions will influence the arrangement of tracks.

c. When selecting the site, consideration should be given to property values, possible arrangement of connections to plant tracks, local railway operating conditions, future expansion of elevator plant and of existing railway facilities.

d. Proposed method of railway operation should be established and approved by the elevator operating company and operating officials of the railway.

#### 4.4.1.2 Types

There are four general types of grain elevators, viz.,

- rail to rail,
- rail to water,
- water to rail, and
- truck to rail.

Specific plants may be combinations of these types.

#### 4.4.1.3 Tracks

##### 4.4.1.3.1 Loading and Unloading

a. The number and capacity of unloading tracks will depend upon the type, arrangement and capacity of elevator unloading facilities, but may be limited in some cases by the space available.

b. The car capacity of the tracks in advance of and beyond the loading or unloading facilities should be the same.

c. Where the car capacity of the unloading tracks on each side of the unloading facilities is equal to the normal daily unloading capacity of the elevator plant during the grain handling season, and where the car capacity of the loading tracks on each side of the loading facilities is equal to the normal daily business handled, the plant switching will be reduced to a minimum.

d. Double-ended tracks will permit the continuous movement of cars in one direction and facilitate switching.

e. Spur unloading tracks may necessitate switching cars through unloading shed and over unloading facilities, requiring the use of idler cars. Locomotives should not be permitted to enter the unloading shed.

f. Adverse gradients and curvature in tracks will limit the capacity of car haul and should be avoided. An assisting gradient to and from the loading and unloading facilities should be provided. A short runoff gradient below the unloading facilities will speed up the movement of empty cars.

g. Where car unloaders are used, the track arrangement should provide for the relative increased capacity of this device. A small plant locomotive or other special car handling equipment should be considered in connection with car unloaders. Flexibility of track layout in the vicinity of car unloader, to facilitate the operation of plant locomotive, should be given special attention.

h. Loading tracks may be located on the same or opposite side of "workhouse" from unloading tracks.

i. Certain unloading tracks may be used for loading or to augment the capacity of the loading tracks.

j. Some of the auxiliary buildings, such as storeroom and dust house, may be served by the loading tracks.

k. If elevators are being converted to accommodate longer train lengths for unit train operation, to the extent that space is available, the existing tracks or yard should be appropriately lengthened to reduce the number of times the train must be broken to enter or leave the elevator.

#### 4.4.1.3.2 Other Tracks

a. A running track, located outside of unloading shed, should be provided where double ended tracks are installed.

b. Although most elevators now use commercial electrical power, if the elevator includes a power house with rail-delivered fuel, a separate track should be provided to the power house.

#### 4.4.1.4 Storage Yard

a. The use of a separate storage yard will require additional handling of cars; therefore careful consideration should be given to the advisability of such a yard.

b. Where the elevator is located near an existing yard and sufficient capacity is available, or can be economically provided, a separate storage yard may not be required.

c. A separate storage yard may be justified where it can be used to augment the existing yard during seasonal increases in business, or where the elevator is located some distance from the main or an auxiliary yard.

d. The capacity of either the loading or unloading tracks, or both, may influence the necessity for a separate storage yard, as well as the capacity of such a yard.

e. Facilities for inspection of cars and lading should be provided.

## 4.4.2 DESIGN OF BULK GRANULAR SOLIDS TERMINALS (2015)

### 4.4.2.1 Introduction

Railroad bulk granular solids terminals are specialized freight terminals which are used to transfer bulk lading from point of origination to rail cars, transfers from rail cars to point of destination or to transfer bulk lading between rail and other modes. For additional pertinent information regarding design of bulk granular solids terminals, refer to Bulletin 660, Proceedings

Volume 78, November-December 1976, pages 255-259, and Bulletin 713, Proceedings Volume 88, December 1987, pages 395-424. This section is applicable to dry bulk solids such as aggregates, coal, phosphates, ore, and coke, which suffer little or no damage from normal handling or from exposure. A search of other bulletins may offer additional information on other materials or design options.

#### 4.4.2.1.1 General

Factors affecting terminal design include number and types of materials to be handled, the size of shipment (unit train, ship or barge, multiple car, single car), the physical characteristics of the site, and the degree of processing and storage to be done on the site.

#### 4.4.2.1.2 Site Selection

The site should be selected to accommodate both near and long term development of the site. The following factors should be considered during layout and planning of the site.

##### 4.4.2.1.2.1 Environment

Environment factors to be considered include:

a. Air, especially dust control and collection.

b. Water.

c. Noise and lighting.

d. Rainfall runoff.

e. Archaeological and Historical Sites.

f. Adjacent development.

g. Proximity to residential areas.

h. Adjacent development.

i. Avoidance of wetlands and other ecologically sensitive areas.

##### 4.4.2.1.2.2 Economics

Site selection and arrangement should allow for economy in movement of materials and transportation operations.

##### 4.4.2.1.2.3 Size

The terminal should include sufficient land area to accommodate the ultimate development of the terminal. Sizing of equipment and structures should allow for expansion and flexibility.

##### 4.4.2.1.2.4 Access

a. Design of highway access should consider the requirements for service vehicles and heavily loaded trucks normally associated with bulk terminals. Water access should include sufficient draft maneuvering space and berthing for the size and type of vessel anticipated at the terminal.

b. Rail access should be designed for the longest and heaviest anticipated shipments arriving or departing by rail at the terminal.

#### 4.4.2.1.2.5 Utilities

Siting and planning should account for required utilities at the site. Water will be required for fire protection, dust control, and washdown. Bulk handling equipment may require a significant amount of electrical power, and some sewage disposal is generally necessary.

#### 4.4.2.1.2.6 Zoning

Siting near residential, commercial, or recreational areas is almost always a controversial issue, with potential delays from hearings and other legal process. Many governmental entities have enacted zoning laws that govern construction of these facilities. It is desirable to avoid areas where rezoning is necessary in order to construct the facility.

### 4.4.2.2 Facilities

Facilities vary with the size and function of the terminal, but can be classified into the following categories.

a. Unloading.

b. Loading.

c. Storage and Reclaim.

d. Conveyance.

e. Sampling and Weighing.

f. Service Facilities.

#### 4.4.2.2.1 Unloading Facilities

Unloading facilities vary from low volume single or multiple-car systems to the high-volume terminals capable of unloading unit trains. The unit train terminals may be rotary or bottom dump unloading. In some specialized applications, side-dump equipment or trains equipped with under-hopper conveyors may be more economically utilized, which simplify or eliminate fixed unloading facilities.

#### 4.4.2.2.1.1 Unloading Facilities for Single or Small Multiple-Car Shipments

a. A small under-track pit with lading removal by conveyor or small mobile equipment is economical in many cases for small shipments. Design of a pit of this type is shown in Chapter 15, Steel Structures, Section 8.4, Unloading Pits. Car shakers may be used to aid in clearing lading from the car.

b. Rotary dumpers can also be used for multiple-car shipments. Rotary dumping may offer advantages if lading tends to freeze or to clog during unloading from bottom-dump equipment. Rotary dumpers can be equipped to take various sizes of cars when the cars are uncoupled before dumping.

#### 4.4.2.2.1.2 Unit Training Unloading

a. Unit train unloading facilities must be designed to unload as quickly as possible to take advantage of the high utilization economies of unit trains. Unloading without uncoupling or switching should also be a high priority in most instances.

b. Fast unloading automatic bottom dump hopper cars unloading in-motion over a pit or trestle provides the fastest unloading time of any bulk granular material unloading system. The unloading facilities must therefore be designed for high mass flows through the facility. Particular attention should be directed to prevention of "bridging" of material in

the bottom of the unloading pit, and reliability of feeders and conveyors to minimize expensive delays in train unloading.

c. Rotary dump facilities using train positioners and rotary coupler equipped cars also have a high unloading rate. Rotary dumper systems generally utilize cars with lower tare weights, and thus higher capacities per car. Reliability of the dumper machinery is a key item in the design of rotary dump unit train facilities to minimize expensive delays in train unloading. Train positioner design should provide sufficient power to handle the unit train easily during unloading.

#### 4.4.2.2.1.3 Frozen Lading

To aid the unloading of frozen lading in cold weather climates, provisions should be made for thawing lading which is susceptible to freezing. Additives to the lading, thaw sheds or pits, and car shakers are all methods which have been used to aid the unloading of frozen lading.

#### 4.4.2.2.2 Loading Facilities

a. For all loading facilities, accurate weighing of lading is essential to take full advantage of the car capacity without overloading.

b. Loading of small shipments may be accomplished with clamshell-equipped cranes, shovels, or other mobile equipment. Hoppers over the track, or conveyors can also be used to load single or small multiple car shipments economically.

c. For unit trains, a high capacity load-in-motion system should be considered to minimize train delays. Weighing bins to accurately meter lading into each car, based on the car's empty weight, will allow maximum advantage of the capacity of the train.

d. In general, excess switching should be minimized during loading operations.

### 4.4.2.3 Storage and Reclaim

a. Most bulk granular materials handling systems require some type of storage and reclaim system. Storage may be necessary for seasonal or environmental reasons, surges in material flow, blending, or through put demands. Multiple types of materials may be stacked, and blending of materials may be required.

b. Design of storage and reclaim systems should take advantage of gravity flow wherever possible, and also minimize handling of materials. Stacker/reclaimer equipment should be sized for the expected terminal throughput, so that train loading and unloading are not limited by this equipment. Covered stacks, silos, or sheds should be utilized to protect materials from exposure if necessary. Dusty materials should be covered or otherwise protected to control fugitive dust emissions.

### 4.4.2.4 Conveyance

Conveyors are the links between the functions of most bulk terminals. Conveyor design should consider the desired material flow rate, material density, and angle of repose. If the terminal may expand at some future date, provisions for dual conveyors or other necessary facilities should be included in the initial design. Some conveyors may be critical enough to require dual systems so that delays in loading or unloading trains, ships, or vehicles may be avoided.

### 4.4.2.5 Sampling and Weighing

Sampling and weighing provisions should be provided where required for each material handled. The AAR Scale Handbook (included in this manual) provides guidance on weighing facilities.

### 4.4.2.6 Terminal Tracks

a. Bulk handling terminals will very likely be served by cars with 286,000 pound gross weight, with a trend toward larger capacity cars. Trackage and subgrade in bulk handling terminals should be designed for these heavy axle loadings.

b. For rotary dump installations, heavy anchorage of rail should be used on the inbound side of the dumper to prevent rail creepage into the dumper platen or other machinery.

c. Rail lubricators may be beneficial for reduction of rail and flange wear.

#### 4.4.2.6.1 Track Geometry - Unit Train Facility

a. For unit train trackage, consideration should be given to train action and conservative curvature and gradient standards. The following criteria are recommended for unit train trackage design:

- Maximum recommended curvature on loops and lead tracks: 7 degrees, 30 minutes.
- Maximum recommended gradient on approach to loop: 1%, compensated for curvature.
- Gradient on unloading loop: (level), or slight upgrade to unloading trestle or pit.
- Minimum recommended size loop and lead turnouts: Number 10.
- Maximum recommended rate of change for vertical curves: 0.12 per 100 foot station in sags. 0.20 per 100 foot station in summits.

b. The AAR Train Performance Calculator or other similar programs can be run to verify train performance over the new design.

c. Trackage affecting the operation of dumpers, train positioners and other material handling equipment should take into account the requirements and recommendations of the equipment manufacturers.

#### 4.4.2.6.2 Track Geometry - Non-Unit Train System

a. Trackage of non unit-train terminals varies widely with the type of terminal. Switching is more common in this type of terminal, and trackage should be designed accordingly. Yard design criteria from other sections in this chapter should be considered in trackage design.

b. Sufficient car storage track should be available to accommodate surges in traffic with adequate room allowed for switching cars through the loading or unloading facilities.

c. In general, the following track design standards are recommended:

- Maximum recommended curvature: 12 degrees, 30 minutes.
- Minimum recommended turnout: Number 8.
- Lead Tracks: as long as the longest storage track.
- Gradients: preferably flat, unless cars are moved through the dumper by gravity. Grades for storage tracks should be such that the application of hand brakes is not necessary.

d. In some terminals, where cars are moved by a combination of gravity and barneys or other car movers, the principles of hump yard design and automatic classification yard design can be used to design the trackage. These principles are found in Part 2, Freight Yards and Freight Terminals.

#### 4.4.2.7 Structures

Structures in granular bulk material handling terminals should be designed for durability and easy cleaning. Electrical equipment and other sensitive equipment may require air conditioning and dust-free environment. Clearances for railroad and mobile equipment should be considered. Additional guidance for structural design and construction are found in the Manual, Chapter 5, Track; Chapter 6, Buildings and Support Facilities; Chapter 8, Concrete Structures and Foundations; and Chapter 15, Steel Structures.

#### 4.4.2.8 Maintenance and Housekeeping

Bulk materials facilities should be designed for easy maintenance and housekeeping. Areas where potential material spills are likely should provide access for loaders and trucks for easy removal of spills. Particular attention should be given to the prevention of dust accumulation. Materials used in construction of a bulk material terminal should be resistant to deterioration from the materials handled.

## SECTION 4.5 BULK-FLUIDS

### 4.5.1 INTRODUCTION (1996)

a. Bulk fluid terminals are specialized freight terminals which are used to transfer bulk lading from point of origination to rail cars, from rail cars to point of destination, or between rail and other modes of transportation. Some terminals may be designed purely for the transfer of commodities to other modes or directly to a customer, whereas other terminals may provide intermediate storage between modes, or storage on behalf of the customer.

b. This section is applicable to bulk liquids such as chemicals, petroleum, fertilizers, food-grade liquids and oils. Also, some dry bulk solids such as powders and granules, which have physical characteristics similar to a liquid, and are handled as fluids rather than as solids.

c. These commodities could be transported in single or multiple railcar blocks, or in unit train service. Some commodities, such as petroleum products, may be transported in railcars with interconnected piping to allow unloading and loading of several railcars from a single point.

d. Contingent upon the customer service to be afforded and the commodity to be handled, terminals may range in size and purpose from a single track, single car spot facility to a multiple track facility capable of unloading or loading unit trains. Individual customers may be served at a terminal or multiple customers may share the facility and its equipment. One or more different commodities may also be handled in the same terminal.

e. Factors affecting terminal design include number and types of materials to be handled, the size of shipment (i.e. unit train, ship, barge, multiple car, single car), the physical characteristics of the site, and the degree of processing and storage to be done on the site.

f. Although consideration herein is primarily directed to such common transfer terminals, design principles may be applicable to in-plant and other transfer facilities.

## 4.5.2 SITE SELECTION (2015)

a. The site should be selected to accommodate both near and long term development of the terminal to handle the volumes of traffic projected for each commodity. Ease of access for customers and all modes of transportation involved are critical in selecting a site suitable for a terminal. Site selection and configuration should allow for economy in movement of materials, unloading and loading equipment, and transportation equipment.

b. Modification of an existing yard, particularly a team yard, may permit utilization of little used assets and use to advantage a site with good access. In other instances, selection of an active, new or undeveloped location may be prudent.

c. The following factors should be considered during the selection, planning and construction of the site.

### 4.5.2.1 Environment

Various chapters of this Manual discuss environmental considerations in detail. Environmental items relating to a site that typically impact terminal design that should be considered include:

a. Air pollution (vapor and dust control and collection).

b. Water pollution (rainfall runoff, spill containment, treatment facilities).

c. Spill containment (for liquids and solids).

d. Noise levels (impact on terminal employees and surrounding areas).

e. Light pollution (from terminal lighting, vehicles, equipment).

f. Proximity to archaeological and historic sites.

g. Proximity to residential areas.

h. Adjacent development.

i. Proximity to ecologically sensitive areas including wetlands.

### 4.5.2.2 Size

a. The site selected for a terminal should have sufficient land area to allow future expansion and development of the terminal. Sizing of equipment and structures should allow for expansion and flexibility of operation.

b. The length of time allocated to discharge vessels, railcars, trucks and storage areas and the frequency of transportation service will impact the sizing of various elements of a terminal.

c. Bulk fluid terminals will include the more recent terminals for ethanol and crude oil in unit trains.

### 4.5.2.3 Access

#### 4.5.2.3.1 Roads

a. Highways, streets and other roads to be used for access must provide an efficient route for customers. Routes to the site should be carefully studied for their ability to accommodate trucks and equipment that will serve the terminal. Road weight restrictions including seasonal restrictions, pavement widths, curves, intersections and existing traffic volumes and patterns should all be considered relative to the size and type of trucks and equipment that will use them.

b. Routes for trucks serving the terminal should also be carefully studied to determine whether they will pass or be near schools, hospitals, parks, community centers, residential areas, and other sensitive areas. Local ordinances may exist that prohibit truck traffic on certain roads. Also, site selection should consider public opposition that may prevent new or additional traffic on certain roads.

c. Site access for emergency vehicles should also be considered, incorporating specific access roads or gates into the site plan as necessary for use by emergency vehicles only.

#### 4.5.2.3.2 Waterways

Water access should provide sufficient draft, maneuvering and turning basins, and berthing space for the size and type of vessels to serve the terminal.

#### 4.5.2.3.3 Rail

Rail access should be designed to efficiently accommodate rail traffic serving the terminal's customers. The length of cars, locomotives and trains, frequency of switching movements serving the terminal, and the characteristics of existing mainline train movements and other operations, should be considered.

The availability of existing tracks or the ability to construct new tracks in yards or along running or main tracks to support the short and long term needs of the terminal should be considered.

For bulk fluid unit trains there will likely be a requirement to be able to accommodate one or more unit trains on site without fouling the main line. This requirement also includes direct connections to the main line with accommodation for signals and approach circuits where applicable.

#### 4.5.2.4 Utilities

Utilities required for the site should be considered during the terminal site selection process. Water will be necessary for fire protection, employee washdown (i.e. showers, eye washout), dust control, equipment cleaning and employee facilities. Electrical power will be needed for commodity handling equipment, lighting, heating/cooling/ventilation equipment and other equipment. Sewage disposal is likely to also be needed.

#### 4.5.2.5 Zoning and Permitting

a. Many governmental agencies have enacted laws which may impact the selection and construction of bulk fluid terminals. Proposals to locate this type of terminal in areas not properly zoned or near residential, commercial or recreational areas including schools and hospitals are frequently controversial to the public. Public hearings and other legal processes frequently become necessary when a zoning change or when a controversial site is selected.

b. Permits of some description are generally required at nearly all locations.

c. Schedules for placing a terminal in-service should consider the time associated with such hearings and legal processes and obtaining permits. In situations in which the timely completion of a terminal is critical, it may be prudent to select a site that will not arouse controversy.

## 4.5.3 UNLOADING AND LOADING FACILITIES (1996)

a. Unloading and loading facilities at terminals may vary from low-volume, single or multiple car and customer systems to high-volume systems for unit trains. Contingent upon the function of the terminal and the commodities to be handled, the transfer of commodities may be between railcar and truck, railcar and storage tank, railcar and water vessel, truck and storage tank, and/or truck and vessel. In any case, the facilities must be carefully designed to meet the needs of its customer or customers.

b. For low-volume terminals, small portable or fixed pump systems may be utilized, and similarly, small portable or fixed vacuum systems may be utilized for powders or granules. Some commodities being transferred between a railcar and truck in low-volumes may be handled using the truck's onboard pump or vacuum equipment. Intermittent unloading of commodities is also common in smaller terminals and will impact the equipment for the terminal.

c. For larger terminals, stationary, high-capacity equipment may be necessary.

d. In any situation, typical railcar and truck length should be determined for the installation of loading booms or unloading connections at the appropriate interval. Careful consideration must be given to the type of commodity and railcars, trucks, vessels and unloading/loading equipment to ensure compatibility. Also, a careful analysis of the equipment, piping, connections, storage tanks, and other facilities should be done to ensure that they are composed of materials that will not corrode or deteriorate when exposed to the commodity.

e. All equipment, including loading booms and unloading connections, must be retractable to enable it to clear railroad tracks pursuant to the guidelines found in the chapter for Clearances of the Manual.

#### 4.5.3.1 Services

a. Certain commodities may require specialized services to effect their transfer between modes or to and from storage, such as electricity to power transfer machines, compressed air to move powders or granules between vehicles, steam or hot water to decrease viscosity of liquids, and nitrogen to purge railcars and pipelines. Provisions for these services at convenient locations along tracks or in other areas must be considered and incorporated in the design of the terminal.

b. Railcars, trucks and vessels, particularly those with special linings, may require specialized cleaning after each unloading or prior to use for other commodities. Specialized equipment, personnel, and facilities may be necessary to perform these functions to meet regulatory, customer and equipment owner needs and to protect equipment from damage and failure.

#### 4.5.3.2 Walkways

Elevated walkways may be necessary to permit personnel to safely access the top of railcars and trucks for unloading and loading purposes. Retractable, telescoping or hinged walkway sections to reach the tops of railcars and trucks from elevated walkways parallel to the track or driveways, are common. Typical railcar and truck length should be determined to construct these sections at the appropriate intervals.

#### 4.5.3.3 Sampling and Weighing

Sampling, weighing or metering provisions may be necessary for certain customers and commodities. The AAR Scale Handbook (included in this manual) provides guidance on such facilities.

#### 4.5.3.4 Environmental Facilities

a. It may be necessary and required by laws or regulations to construct spill containment systems such as dikes, paving and other appurtenances at unloading/loading areas and in commodity storage areas. To prevent contamination of the atmosphere, vapor or gas collection systems may be necessary or agency required. For some powders and granular commodities, dust collection or abatement systems may be necessary or required. Also, special treatment and pre-treatment facilities for the discharge of water may also be necessary.

b. Various chapters of the Manual discuss environmental considerations and design criteria in detail.

## 4.5.4 COMMODITY STORAGE (1996)

a. Most bulk fluid terminals require some level of storage capability to accommodate fluctuations in commodity demand, unloading and loading constraints between transportation modes, and blending of materials on-site.

b. The transfer and storage systems for a bulk fluid terminal should be designed to utilize gravity, minimize the handling of commodities as much as possible, and be of appropriate size or capacity to unload or load railcars, trains, vessels and/or trucks. Covered unloading or loading areas, stacks, silos or sheds may be desired to protect commodities from exposure and loss. Commodities composed of fine particle size, that are prone to become airborne by wind or other air movements, should be covered or otherwise protected.

## 4.5.5 BUILDINGS (1996)

a. Buildings may be required for a variety of purposes. These could include offices and supporting facilities for employees, commodity storage, enclosure of commodity transfer areas, protection of boilers, water heaters and transfer equipment, security and any other function or item needed given weather and general site conditions.

b. Structures in bulk material handling terminals should be designed for durability and ease in cleaning. Electrical equipment and other sensitive equipment may require air conditioning and a dust-free environment. Lighting and ventilation must be designed to assure the safety of employees and allow the efficient execution of their duties. Clearances for railroad and mobile equipment should be considered. All structures must meet all applicable OSHA requirements and any local building and fire codes. Additional guidelines for structural design and construction are found in various chapters of the Manual.

c. Office buildings should be located for convenience near the entry to the terminal to allow monitoring of traffic in and out of the terminal, and to monitor the activities within the terminal itself. Separate offices and facilities may be necessary for outside contractors operating all or various portions of the terminal.

d. Certain customers and environmental regulations may require that commodity transfers be performed within an enclosure to protect the commodity from degradation or escape into the atmosphere.

e. Buildings for storage and servicing of transfer and other terminal equipment is typically required at most terminals. It is particularly critical that buildings be provided for equipment handling food grade commodities which require cleaning and protection from contamination. An appropriate work area as might be required for cleaning and maintenance of equipment, and a storage area with racks for hoses, fittings and other items for maintaining the equipment, should be provided in the building.

## 4.5.6 SECURITY (1996)

a. In most instances, the commodities handled at bulk material terminals are of a unit value that security concerns address preservation of purity and protection of equipment.

b. At many sites, no sophisticated security measures are justified, other than to restrict points of entry to the terminal with perimeter fencing and a limited number of gates to allow ease of monitoring during operating hours and closure of the terminal during non-operation.

c. Area and perimeter lighting aids in deterring intruders and allows monitoring at night. Lighting levels should be such that shadowed areas are minimized.

d. Undergrowth and trees should be removed as needed around fences to prevent their use to breach or scale fences, and to allow improved visibility for monitoring the terminal perimeter.

## 4.5.7 ENVIRONMENT AND MAINTENANCE (1996)

a. Bulk material terminals should be designed in conformance with all federal, state and local environmental laws and regulations, and to allow easy maintenance of the infrastructure and equipment to minimize the potential and resulting impact of spills and site contamination. Various chapters of the Manual discuss environmental considerations in detail. Environmental items relating to the design of the terminal that should be considered include:

(1) Air contamination (vapor and dust control and collection).

(2) Water contamination (rainfall runoff, spill containment, treatment facilities).

(3) Soils contamination.

(4) Noise levels (impact on terminal employees and surrounding areas).

(5) Light pollution (from terminal lighting, vehicles, equipment).

b. Equipment and measures should be employed to control and/or collect airborne particles to prevent pollution of the atmosphere, dust explosions, adverse affects on employee health, loss of commodity, and deterioration of facilities and equipment from dust accumulation. The terminal's equipment and facilities should be constructed of materials resistant to deterioration from the commodities handled.

c. Areas where commodity spills are likely should be easily accessible for loaders and trucks to facilitate cleanup. Paving in areas where not structurally necessary may still be desirable to provide a barrier between commodities and the ground.

d. A drainage system should be provided which will effectively remove stormwater runoff to avoid deterioration of work surfaces, contamination of commodities, and minimize the impact upon unloading and loading operations. The systems should be designed to channel runoff to a central location for ease of containment, cleanup and/or treatment of spills, and should be constructed of materials that will not interact with any potential spill material. Similarly, the drainage system should be designed to allow the easy removal of any residue or sedimentation to prevent any potential interaction with any other materials spilled.

## 4.5.8 TERMINAL CONFIGURATION (2003)

a. The terminal should be configured to provide the most efficient movement of commodities, transfer equipment and transportation vehicles. Security, safety and environmental facilities and appurtenances appropriate to the commodities handled should be considered in the design. Service facilities and utilities should be strategically located to allow easy access without conflicting with other operations, activities or movements within the terminal.

b. The length of time allocated to discharge vessels, railcars, trucks and storage areas and the frequency of transportation service will impact the configuration of various elements of a terminal.

c. See Figure 14-4-15 and Figure 14-4-16 for examples of bulk fluid terminals.

### 4.5.8.1 Tracks

a. Bulk fluid terminals may be served by tank cars and/or covered hopper cars of varying lengths and capacities contingent upon the commodity being carried. At low-volume terminals, railcars tend to be switched individually or in relatively short blocks or "cuts," whereas at high-volume or large terminals, larger blocks or unit train movements may be employed. Track lengths, switching leads and ladders must be designed pursuant to the type of operation or service planned.

b. The overall design of the terminal, including the track configuration, must provide adequate room to accommodate driveways for unloading and loading equipment, service equipment and inspections. Also, the design must minimize any conflicts between trucks, unloading and loading equipment, and rail movements to allow the terminal to operate as efficiently as possible. Intermittent unloading of commodities is also common in smaller terminals and will impact the configuration of the terminal.

c. For terminals to receive individual or short cuts, relatively short track lengths for unloading and loading may be prudent to allow switch engines easy access to individual railcars. Multiple, short tracks may be necessary to enable switching without having to halt or await the completion of other railcar unloading or loading activities, or move partially loaded railcars.

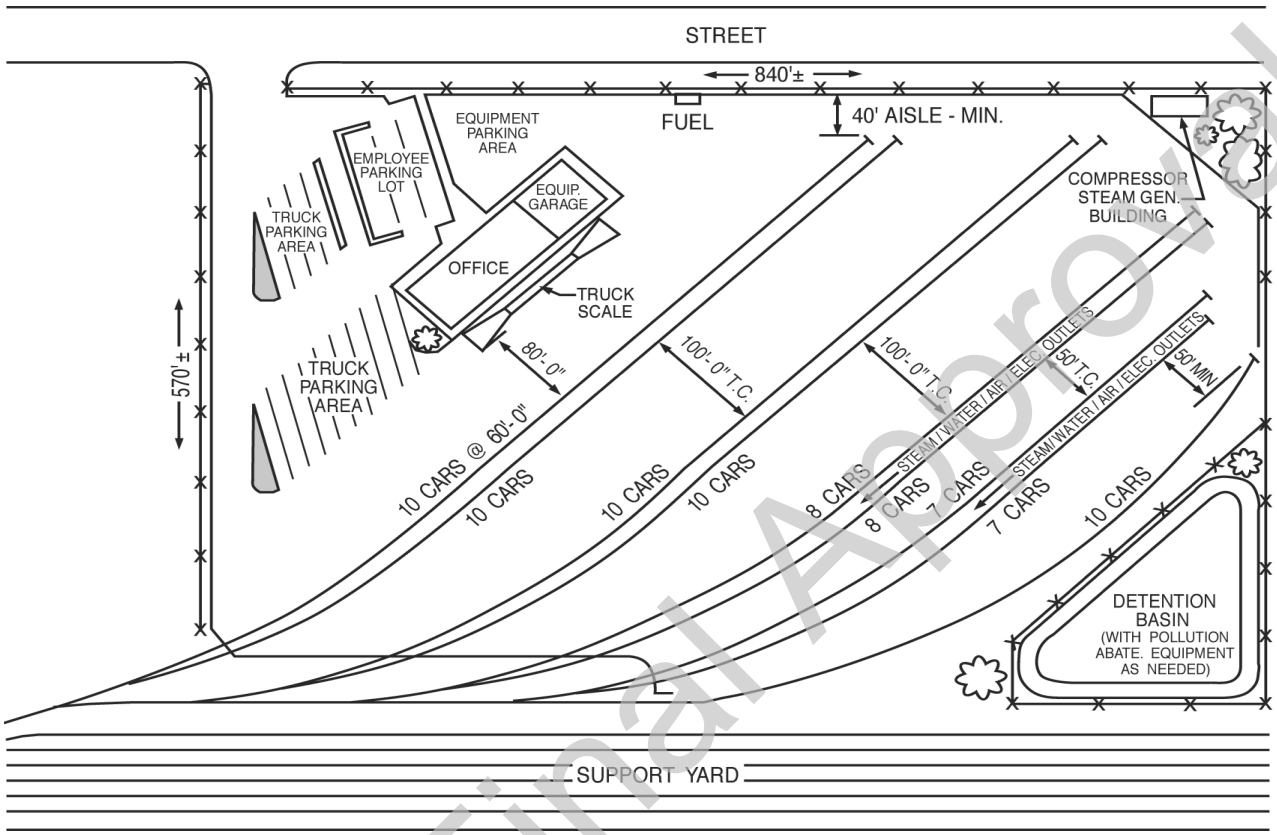


***Figure 14-4-15. Bulk Fluid Transfer Terminal – Single End Switching Capacity: 80 Cars Spotted. 11± Plus Storage/Support Yard***

d. For terminals to receive longer cuts or unit train service, longer unloading or loading, lead and storage tracks lengths will be necessary.

e. In terminals where access is needed only on one side of a track for unloading or loading, tracks may be configured in pairs with services and lighting required placed between the tracks. Paired tracks must have track centers that provide clearances which conform with the guidelines presented in the clearance chapter of the Manual and governmental regulations.

f. Covered hopper cars can be expected to range from 100 to 125 tons, therefore, trackage and subgrade construction should be of a design to accommodate heavy axle loadings.

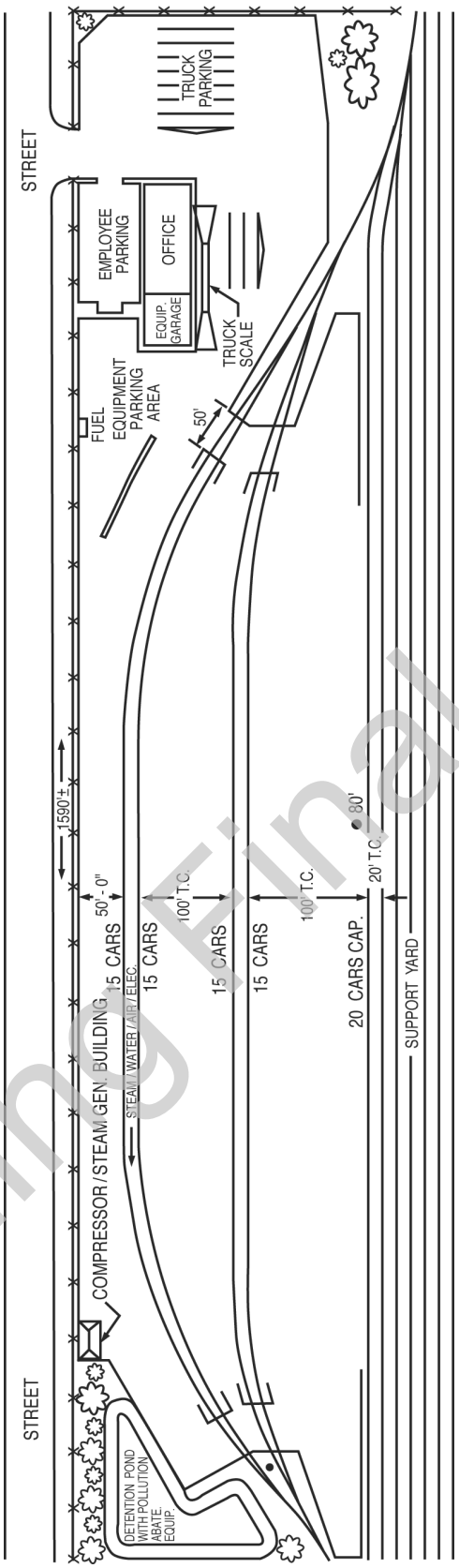


*Figure 14-4-16. Bulk Fluid Transfer Terminal – Double End Switching Capacity: 80 Cars Spotted. 11± Plus Support Yard*

g. Blue flag protection should be provided at unloading and loading locations in the terminal, or any other location where employees will be working on top of, beneath, or inside of railcars.

#### 4.5.8.1.1 Track Geometry - Non-Unit Train Operation

a. Trackage for non-unit train terminals varies widely with the type of terminal. In general, the following track design standards are recommended:

- Maximum curvature - 12 degrees - 30 minutes.
- Minimum turnout - Number 8.
- Lead tracks - Length should be as long as the longest storage track.
- Gradients - preferably flat or sloping toward the end of track at a grade not to exceed 0.1%; grades for storage tracks should be such that application of hand brakes is not necessary; a slight ascending grade should be included at either end of the storage tracks to prevent rollouts.

b. In some terminals where cars are moved by gravity, the principles of hump yard design can be used. These principles can be found in Part 2, Freight Yards and Freight Terminals.

#### 4.5.8.1.2 Track Geometry - Unit Train Operation

a. For trackage to accommodate unit trains, curvature and gradients should be designed with unit train dynamics considered. The following criteria are recommended:

- Maximum curvature on loops and lead tracks: 7 degrees - 30 minutes.
- Maximum gradient on approach to loop: 1% compensated for curvature.
- Gradient on unloading loop: Level or slight ascending grade.
- Minimum turnout for loop and lead: Number 10.
- Maximum rate of change for vertical curves: 0.12 per 100 feet in sags; 0.20 per 100 feet in crests.

b. The AAR Train Performance Calculator or other similar train dynamics simulators can be run to verify train performance over a proposed design.

c. Trackage affecting the operation of unloading and loading equipment, train and other material handling equipment should take into account the requirements and recommendations of the equipment manufacturers.

#### 4.5.8.2 Driveways

a. At locations where the transfer of commodities between rail and trucks is to occur, driveways of sufficient width must be provided on at least one side of each unloading or loading track to permit a truck to park. The width allowed for each truck should be 12 feet plus any width required to angle a truck relative to the track and railcar. Additional width must be provided to allow other vehicles to safely pass the parked truck and for sufficient space to position any transfer equipment. Adequate turning radii for trucks must be provided to promote the unobstructed and efficient flow of traffic and equipment.

b. Parking for employees and visitors should be provided in a separate area from the terminal operations to minimize traffic congestion and promote security of the terminal's equipment and supplies. Parking should be located in close

proximity to the office building, but positioned so that pedestrians and vehicles are clear of the circulation of trucks, equipment and other vehicles.

c. Paving must be designed to support the loads anticipated from fully loaded tractor trailer trucks and transfer equipment. Selection of pavement materials must be appropriate to the service. Some commodities may damage pavement if spilled, such as petroleum products in contact with bituminous concrete. Crushed stone or gravel may be appropriate at smaller terminals, however, some aggregate particles may interact with commodities or its dust may contaminate commodities. Also, spills onto stone areas can be difficult to clean up and could allow contamination of ground beneath the stone paving.

d. For guidelines concerning road and pavement design, see the "AASHTO Guide for Design of Pavement Structures," published by the American Association of State Highway and Transportation Officials, Chapter 4. Paving materials and construction methods for a given area are typically specified to meet state or local highway authority specifications.

#### 4.5.8.3 Truck Scale

1. Many customers require that commodities and drayage be weighed at the terminal. The location of the scale should be carefully planned to allow trucks easy access to the scale without adversely affecting activities elsewhere in the terminal when entering and exiting the terminal. The location of the scale should also permit trucks to easily return to an unloading area if necessary to "top off" their load.

   a. It may be desired to position the scale in close proximity to the terminal office to allow scale equipment to be placed within the building for protection and use by office personnel.

## SECTION 4.6 MERCHANDISE TERMINAL

### 4.6.1 PRODUCE TERMINALS (2004)

#### 4.6.1.1 General

a. Produce terminals are designed for expeditious distribution and transfer of various commodities such as fruits, vegetables, some dairy products, meat and meat products, seafoods and dry groceries between truck and rail modes of transportation. However, these terminals are generally no longer built and operated by railroads. Separate companies have taken over this function so that railroads now only provide switching services for the facility. In addition much of the produce is now handled in refrigerated trailers which are then handled through the railroad's intermodal facility. From a railroad perspective, the railroad only coordinates with the shipper or owner of these facilities.

b. Terminals should be located and designed to handle peak business.

c. A union terminal serving the entire trade of a community is preferable.

d. The location must be convenient for dealers, with easy access over wide and well improved highways and easy gradients. It should have convenient railway connections. A location adjoining a railway terminal yard is advantageous.

#### 4.6.1.2 Functions of Railway and Marketing Facilities

a. A produce terminal should be considered to include:

   (1) railway facilities.

(2) wholesale marketing facilities.

(3) team yards.

b. Railway facilities include the primary units for handling carload shipments prior to distribution or reconsigning. Any or all of the following facilities may be required:

(1) Receiving and delivery yard.

(2) Hold and inspection yard; with or without supplemental classification tracks.

(3) Team yard.

(4) Buildings for sorting, reconditioning and transferring of lading.

(5) Administration building.

(6) Motor truck sales.

(7) Buildings for coopering and supplies.

(8) Buildings for heaters and supplies.

(9) Rest rooms for yard crews, stevedores, truck operators and laborers.

(10) Incinerator.

(11) Communication facilities.

(12) Yard lighting.

(13) Icing facilities.

(14) A track system for serving the yards.

(15) A system of driveways for movements to and from the team yard and the hold and inspection yard.

(16) Fire protection facilities.

c. Wholesale marketing facilities include units for the sale and distribution of produce and may be situated adjacent to or within easy access of the railway facilities. In either case certain units should be served directly by railway tracks. Any or all of the following units may be required:

(1) Buildings divided into separate stores.

(2) Buildings for display and private sales.

(3) Buildings for display and auction.

(4) Auction rooms.

(5) Offices, restaurants, etc.

(6) Cold storage warehouse.

(7) Bulk delivery platforms.

(8) Ripening facilities.

(9) Reconditioning facilities.

(10) Motor truck and other scales.

(11) Incinerator.

(12) Communication facilities.

(13) Fire protection facilities.

(14) Farmers' market.

(15) A railway track system serving the buildings.

(16) Driveways serving the buildings.

(17) Separate buildings for individual large firms.

(18) Adequate parking areas.

d. The location of a team yard should be such that it will be convenient for use by shippers and consignees, and also as convenient as possible to a freight house, so that the receipt and shipment of freight may be easily under control of the freight agent's force.

(1) Equipment. A crane for handling heavy freight should be provided when required. A motor truck scale, with office, should be provided near the main entrance to the team yard when required.

(2) Tracks.

(a) Switching tracks for holding and working cars should be provided in the immediate vicinity of the team tracks and so arranged as to facilitate the switching of these tracks.

(b) The spacing of tracks, where multiple team tracks are built, may be fixed by regulatory bodies, but it is recommended that the minimum distance between track centers be 14 feet.

(c) The distance between track centers where the driveway is located between tracks should be 16 feet greater than the width of the driveway.

### 4.6.1.3 Layouts

#### 4.6.1.3.1 Track

a. The track layout should be as compact and flexible as possible, and extensive enough to take care of traffic without delay. It is governed by the number of cars handled at peak periods, the different kinds of produce received, and the average standing time until cars are released.

b. A receiving and delivery yard is sometimes desirable for receiving transfers from various roads and for assembling outbound empties and reconsigned cars.

c. A hold and inspection yard is sometimes provided. This yard should have two-lane driveways between pairs of tracks to permit access for inspection and icing from trucks.

d. Inspection platforms are sometimes provided. It may be a separate yard or combined with the receiving and delivery yard or with a small classification yard.

e. Team yards should have ample standing capacity. Extremely long tracks should be avoided.

f. Track centers should be not less than 14 feet.

#### 4.6.1.3.2 Buildings

a. Ample floor space should be provided for mechanical handling from cars to warehouse floor, display of produce and assembly of various lots for delivery to trucks.

b. The column spacing should be given careful study and be as wide as possible, consistent with economic design.

c. The backup space for trucks should be as liberal as possible.

#### 4.6.1.3.3 Platforms

a. Platforms used for inspection or jointly for inspection and handling of produce should be not less than 12 feet (3.7 m) in width, 3′-5″ (1.1 m) above top of rail when the center line of tangent track is 5′-9″ (1.75 m) from the platform, or 4′-7″ (1.4 m) above top of rail when the center line of tangent track is 8′-0″ (2.45 m) from the platform. Platforms should be covered, and light and water should be provided. Roof supports should be located to minimize interference with handling crates. Space for crate storage and repairs is usually required.

b. House platforms, when served by both highway vehicles and railway cars, should be 4′-4″ (1.3 m) above top of rail and 8 feet (2.45 m) from the center line of tangent track.

c. Clearances must comply with state regulations.

### 4.6.1.4 Facilities

#### 4.6.1.4.1 Garbage and Refuse Disposal

Cars should be thoroughly cleaned after unloading, and all refuse and garbage removed from platforms, buildings, etc. Cleaning of cars may be accomplished on a one-spot basis with mechanized devices. Special equipment such as sweepers, dump carts, etc., should be provided in large terminals. Garbage may be handled by city collection, by contract, or incinerated. An incinerator, if required, should be of ample capacity to handle each day's collection in 6 to 8 hr, conveniently located, and designed to burn garbage having a high water content.

#### 4.6.1.4.2 Mechanical Refrigeration

The cooling and in some cases heating of rail cars and trailers is now provided by mechanical refrigeration units. In some instances rail cars also are treated with various types of gases or chemicals to inhibit deterioration of the produce. Provisions may be required to perform maintenance functions on this equipment.

#### 4.6.1.4.3 Miscellaneous

a. Ample drainage is essential for buildings and yards.

b. Floodlighting the entire area is desirable in addition to local lighting.

c. The entire area should be strongly and closely fenced to prevent trespass.

d. Definitely assigned entrances and exits should be provided.

e. A cold storage warehouse, if required should have suitable track service and convenient means of communication with other buildings.

f. Adequate parking space should be provided.

g. Motor truck scales, when required, should be located at a point convenient for the drivers and near the freight office. The location should not interfere with truck movements in the driveways.

## SECTION 4.7 MUNICIPAL SOLID WASTE (MSW) TERMINALS

### 4.7.1 GENERAL (2000)

a. The conveyance of MSW usually begins and ends with short truck hauls, with a long rail haul in between.

b. Rail haul of MSW may be in unit trains or in cuts handled in regular freight consists.

c. The ultimate destination of MSW may be either a sanitary landfill or a power generating plant.

d. Construction of MSW handling facilities may involve extensive government permitting and public hearings, for which adequate time should be allotted.

e. MSW handling facilities should be constructed so as to shield the public from offensive odors, sights, lights, sounds, dust and vermin.

### 4.7.2 MSW RAIL HAUL EQUIPMENT (2000)

a. The type of container to move MSW is dictated by:

(1) Volume of MSW to be moved.

(2) Configuration of MSW collection system

(3) Proximity of rail terminal to disposal site

(4) Proposed ownerships of facilities and equipment

b. Various containers used for hauling MSW:

(1) Truck trailers on specialized flat cars (TOFC)

(2) Containers on specialized flat cars (COFC)

(3) Convertible road-rail truck trailers

(4) New or used boxcars modified by adding interior dividers and removable roofs.

(5) Hopper and gondola cars

## 4.7.3 SITE SELECTION (2000)

a. Desirable site attributes:

(1) In industrial or rural area

(2) Properly zoned for proposed use

(3) Minimum of environmental issues involved (wetlands, endangered species, etc.)

(4) Good highway access with minimum city street use

(5) Near sources of MSW, with balanced hauls and cycling times for collection trucks

(6) Adequate room for receiving, brief storage, sorting and handling of MSW

(7) Accommodates efficient transfer of wastes between road and rail modes without conflicts

(8) Proper site drainage can be achieved

(9) Room for future expansion

## 4.7.4 CONSTRUCTION OF FACILITIES (2000)

a. Transfer station - truck to rail car

(1) Consider truck axle loadings and turning radii, and density of traffic to be generated

(2) Develop location of truck entrances and exits with local highway agencies

(3) Determine if weighing of entering trucks may be necessary to establish dumping charges

(4) Determine if weights of loaded rail cars:

(a) May be needed if agreed to average lading weights are not to be used

(b) Should be remotely read using electronic coupled-in-motion scales

(5) Transferring waste from truck to rail cars:

(a) Minimize exposure of waste to air and light

(b) Move directly from truck to hopper to car, or move from truck onto station floor for sorting out recylables and/or compostables, and then shredding, baling, and loading wastes into rail cars using front end loaders, grappling hooks, etc.

(c) Use grapples to assist in loading and compacting waste in rail cars, and for removing objectionable materials (gas, canisters, hazmat, etc.)

(d) For open top cars provide covers (of metal, canvas, plastic, or netting) to restrain waste during transit

(e) For use of trailers or containers on flat cars, refer to Chapter 14, Section 4.2 Design of Intermodal Facilities

b. Unloading (Disposal) Facilities

(1) Place rail car unloading as close as practical to ultimate MSW disposal

(2) Minimize exposure of waste to air and light

(3) Include system for removing car covers, if any, and returning them to transfer station

(4) When using TOFC or COFC, refer to Chapter 14, Section 4.2 Design of Intermodal Facilities

(5) For modified box, gondola or hopper cars:

(a) Movement through (un)loading areas may be by indexer, barney, or cable and winch, mobile car mover or slow speed locomotive

(b) Unloading may be by rotary dumper, clamshell or backhoe. (see Chapter 14, Section 4.4 Bulk-solid

(6) Transportation of MSW from rail unloading point to sanitary landfill or power generating plant.

(a) Use trailers or containers in which MSW arrives

(b) Unload open top cars with rotary dump, backhoe, grapple, etc.

(c) Use large truck trailers loaded by hoppers, conveyors, backhoes, etc.

(d) Unload containers or trailers at fill using tipping chassis or device

(e) Make final placement of MSW in landfill using grader-scrapers, bulldozers, front-end loaders and patrol graders

(f) Most sanitary landfill operators are required to cover MSW with earth the same day it is placed.

(7) Sanitary landfills for disposal of MSW

(a) Are usually lined with sealed rubber or plastic membranes underlaid with clay to prevent escape of liquids (leachate)

(b) May have a system of perforated pipes to collect and convey leachate to storage tanks for holding, treatment and disposal

(c) If leachate is to be moved from the landfill site by tank car or truck, handling facilities are needed at origin and disposal locations.

(d) Pipes may be installed to gather flammable gases (usually methane) generated by decomposition of wastes, for burning as a power source or flare.

c. Aspects common to transfer and unloading facilities

(1) Provide sufficient utilities:

(a) Electric power for: lighting, waste processing equipment, hydraulic equipment, air compressors, maintenance operations, wastewater pumping and treatment

(b) Water for: sanitary and washdown purposes, fire suppression

(c) Sanitary sewers and treatment facilities (on or offsite) to handle wastewater and car/trailer/container cleaning effluents

(d) Treatment facilities for stormwater runoff, if contaminated

(e) Compressed air for: cleaning operations charging air brakes

(f) Adequate lighting for night operations, safety, and security

d. Layout of trackage

(1) Make extensive enough to easily handle in simple, direct moves the longest MSW unit trains or cuts of cars expected

(2) Provide escape track for road-haul locomotives

(3) Provide room for overnight storage of trains or cars, if required

(4) Track curvature and turnout configurations

(a) Make compatible with equipment to be used for waste train and switching operations.

(b) Make (un) loading and holding tracks as straight and level as possible, with grade not more than-0.1% in direction of movement

(c) Make vertical curves at least 100 ft. (30 in.) long.

(d) Make minimum curve radii at least 460 ft. (140 in.).

(e) Provide at least 100 ft. (30 in.) of tangent between reversing horizontal curves.

(f) Use No. 8 or flatter turnouts.

(5) Use CWR (115# or heavier) in paved areas to eliminate pavement heaving at rail joints.

(6) Use concrete modules in grade crossings to be used by heavy mobile equipment.

(7) Locomotive holding tracks:

(a) Make environmentally safe

(b) Provide facilities for fueling, servicing and light repairs

(8) At waste facilities using TOFC and/or COFC:

(a) Road-haul locomotives usually spot MSW unit trains directly on (un) loading tracks.

(b) Trailers and/or containers are lifted on and off of flat cars using straddle and gantry cranes, front end lifters, etc.

(c) Intermodal flat cars are usually left in place on (un) loading tracks.

(d) Light repairs to intermodal cars (including changing wheel sets) are often done in place on (un) loading tracks.

(e) A spur track may be provided for heavy car repairs if there is room at site.

(f) Prior to arrival of road-haul locomotives, unit or cuts of cars ready for departure should have their air brakes charged using a portable or stationary air compressor, or a switch engine.

e. Buildings

(1) Station for transfer of wastes between modes:

(a) Largest building in facility

(b) Larger at origin if public allowed to dump, and/or there is sorting or salvaging

(c) Keeps wastes out of sunlight and weather

(d) Captures odors, dust and noise

(e) Controls vermin

(f) Shields operations from public view

(g) Any tracks through building need proper clearances (see Chapter 28 Clearances)

(2) Other buildings

(a) Office building

(b) Truck scale house (may be in office)

(c) Locker and washroom facilities

(d) Repair garage for trucks, trailers, grading and other equipment

(e) Building to hold supplies and materials for railroad locomotive, car and track maintenance and repairs

(f) Trailer tipper building at landfill

(g) Gate houses for monitoring and security

f. Security

(1) To inhibit unauthorized entry into sites by trespasser to prevent:

(a) Unauthorized dumping and/or salvaging

(b) Accidents and injuries

(2) Methods:

(a) Have passes and waybills for authorized entrants

(b) Construct fences (or sound wall) around entire facility, with slats where in public view.

(c) Have adequate level of lighting at night.

(d) Install closed circuit TV and gate alarms where few guards are used.

(3) Provide adequate signing:

(a) To inhibit trespassing

(b) To promote orderly flow of authorized traffic

g. Vector Control

(1) Vermin and other animals are attracted by animal and vegetable matter in wastes.

(2) Best method of control is to move waste quickly from origin to disposal at landfill or power generating plant.

(3) Keep wastes covered and away from sunlight and heat to minimize odors caused by putrefaction.

(4) Do essential good housekeeping wherever wastes are handled, sorted or stored.

(5) Do thorough cleaning of waste handling areas and equipment using high pressure water and air.

## SECTION 4.8 TRANSLOADING FACILITIES (OTHER THAN BULK)

### 4.8.1 GENERAL (2019)

Transloading facilities are designed for the transfer of various carload or multiple carload commodities from railcar to truck, truck to railcar or from railcar to short term or long term ground or protected storage. They differ in configuration and purpose from Bulk Terminals in that the commodity handled is generally not fluid or granular in nature (the description of fluid bulk and solid bulk handling in a Transloading environment is described in Section 4.4 and 4.5, respectively). Typical commodities handled at a Transload Facility include lumber, plate or coiled steel, palletized/bagged cargo and oversized items such as heavy machinery. Handling and movement of the commodity in a Transloading Facility is generally more time and labor intensive than other terminals, therefore design of Transloading Facilities poses a different set of requirements.

The simplest type of Transloading facility may be nothing more than a level compacted surface adjacent to a rail siding permitting the manual transfer of lading between a truck and railcar. Facilities of this nature, referred to as "Team Tracks", were typically located adjacent to small railway freight or passenger stations. The consignee would, upon notification of arrival of shipment, transfer cargo to truck. The Railroad, a contract operator, a lessee, or a consignee may own and/or operate the facility.

More complex facilities may include dedicated areas, environmental controls and material handling equipment, such as rail or rubber tire straddle cranes or heavy duty forklifts, specifically suited to a particular commodity.

### 4.8.2 SITE SELECTION (2019)

The site location should provide access to a primary highway network, as well as convenient railway connections. Impacts of increased vehicular traffic attributable to the operation of the facility should be evaluated during the site selection process. Particular attention should be given to traffic patterns that may develop subsequent to the commencement of operations. These include impacts resulting from increased highway traffic, as well as increased railroad movements.

Noise generated by transload operations must be considered. Material handling equipment, highway trucks and the general handling of cargo may generate significant amounts of low frequency noise. Local noise ordinances may preclude 24 hour operations and should be considered during the site selection process.

The owning Railroad, a contract operator, a lessee, or a consignee may own and/or operate the facility.

## 4.8.3 CONFIGURATION (2019)

a. The configuration of the facility may entail one or more single or double ended rail sidings with dedicated track(s) for the rail service provider to drop and pull cars from. Vehicular access to the siding(s) should be provided on each side of each track to accommodate various types of railcar configurations or the specific unloading requirements of the lading. Sufficient distance from track centerline to obstructions such as fence lines, building faces or adjacent parallel tracks must be provided in order for material handling equipment to be able to maneuver. The capacity and geometry of the rail sidings will be determined by several factors such as the type of rail equipment employed, frequency of railroad switching service, volume of rail traffic, nature of commodity mix, and the capacity of and dwell time in, material storage areas or warehousing. Depending on the volumes expected to be handled, designated areas and traffic patterns for transfer operations to "over the road" trucks may be provided.

b. Unloading operations may take place at grade level or require fixed or portable loading docks depending on railcar type. The costs of providing fixed unloading facilities such as docks or ramps will be governed by the expected commodity volumes and the storage requirements of each commodity. Merchandise Terminals with fixed loading docks and warehouses are described in Section 4.6. Generally, commodities shipped in covered railcars are stored under cover. Therefore the loading dock may be an integral part of on-site storage layout. Care must be taken to accommodate railcars carrying lading which, due to shipping constraints may only be unloaded from one side of the railcar. Portable ramps can be employed as a flexible alternative to fixed masonry, timber and earth docks.

c. In the absence of any specific zoning requirements, the site should be located a sufficient distance from residential areas to limit impacts from the generation of noise or dust from normal operations. In addition, the impact of light spillover from any site lighting, should consider, including the use of downcast or shielded lighting fixtures to reduce light spillover.

d. Available real estate will ultimately dictate facility design constraints. In order to minimize construction costs, rail sidings should be located as close to the serving rail spur as possible, with consideration given to proposed and future operating and site development requirements.

e. Transload facilities should also consider truck routing and roadway configuration. This is especially important when operations may require special oversize trailers (length, width, height or weight) to move materials to or from their destinations. With these routings it is also important to match the truck/trailer traffic with the appropriate pavement design (e.g. materials and thicknesses). Clearances for vehicles, trailers, railcars and product storage need to be incorporated into the configuration of the facility.

## 4.8.4 DESIGN CONSIDERATIONS (2019)

### 4.8.4.1 Permitting

Various chapters of the Manual discuss environmental considerations in detail. Permitting items that typically impact Transload Facility site selection, characteristics and design include the following:

a. Zoning and setbacks

b. Air pollution (dust control)

c. Water pollution (storm water runoff/treatment and groundwater impacts)

d. Hazardous material spill containment

e. Noise levels and hours of operation

f. Light pollution (glare/spillage from site lighting, vehicles and equipment)

g. Habitat impacts

#### 4.8.4.2 Site Surface

The vehicular operating area of the Transload facility may consist of densely compacted gravel or dense graded aggregate sub-base material for low to medium volume facilities. The impact of the generation of dust from vehicular operations inherent with this type of paving surface should be evaluated with respect to the nature of the commodities stored on site, as well as any environmental regulations or local building or health code requirements. Consideration should be given to the expected loading exerted by materials handling equipment, trucks and cargo when designing any pavement sections. See Article 4.2.3.3 regarding pavement types.

The site layout should consider the type of roadway vehicles that may be used during the transloading process, and the space and turning radius necessary to facilitate the roadway vehicle's participation in the loading and off-loading process. Consideration should also be given to extending pathways and other surfaces laterally toward the rails to allow rubber-tired vehicles, such as forklifts, to access the interior of the railcars while working from grade.

#### 4.8.4.3 Ancillary Facilities

A truck scale may be required for weighing commodities prior to departure from the terminal in order to prevent overload situations or to satisfy the requirements of a particular customer. The location of the scale should be carefully planned to permit easy access without adversely affecting the other operations of the terminal.

A terminal office, located adjacent to the entrance/exit gate may contain welfare facilities for terminal employees such as showers, a lunchroom and lockers, as well as administrative offices for the terminal operator.

Material handling equipment maintenance facilities may be included at larger terminals where the level of service, nature of equipment or location of the terminal precludes off site repairs. Generally, the equipment maintenance facilities will consist of:

- Portland Cement Concrete pad to facilitate jacking of heavy equipment
- Storage buildings or trailers for parts and tools
- A small shop for work that needs to be performed indoors

Other site-specific items to be considered are:

- Lighting
- "Compressed air system
- "Water for fire protection, consumption, and maintenance purposes
- Equipment fueling apparatus
- Weather protection such as a canopy or enclosed garage
- Sanitary sewer facilities (septic field or municipal connection)

- Product storage racks/cribbing
- Equipment storage areas/building
- Loading/Offloading equipment:
  - Forklifts
  - Off-road forklifts
  - Manlifts
  - Excavators/cranes with attachments
- Snow removal equipment
- Locomotive or trackmobile parking location

#### 4.8.4.4 Security

Minimum site security measures should include perimeter fencing and a lockable entrance/exit gate. While some commodities by their nature pose little potential for theft, others, such as dimensional lumber, represent an attractive target for thieves. In any case, perimeter fencing will serve as a deterrent to trespassers. As an added enhancement to perimeter fencing, highway type steel guide rail on H posts concrete "jersey barriers" or other types of obstructions may be installed inside the limits of the perimeter fencing.

A perimeter alarm, security cameras or security guards may be considered where potential for theft is high due to the site location or nature of commodity handled.

Site lighting in the form of pole mounted floodlights or high mast towers should be considered as an added security measure where operations may occur during hours of darkness.

#### 4.8.4.5 Storm Water Management

Means should be provided to attenuate or prevent discharge of storm water originating within the transload facility in order to satisfy the requirements of state and local flood control agencies. Storm water runoff needs to meet local water quality permits with jurisdiction for National Pollutant Discharge Elimination System (NPDES) of the U.S. Clean Water Act. Any surface exposed to spillage (e.g. from maintenance operations) should route storm water runoff through an oil water separator in order to collect lubricating and fuel oil spills and leaks. In addition, measures may be necessary to contain spilled lading to prevent entry into the local watershed or local storm water or sanitary sewer systems.

Storm water management measures may include detention or retention basins, settlement ponds, infiltration/filtration best management practices, storage tanks, oil-water separators or complex treatment facilities by virtue of the nature of surfaces, maintenance operations, and types of commodities handled by the Transload Facility.

### 4.8.5 FACILITY TYPES (2019)

Some examples of facility types are as follows.

#### 4.8.5.1 Lumber Transfer

Lumber handling and transfer facilities are designed for the transfer from railcar to truck, or from railcar to short term ground or protected storage, of dimensional lumber and other building products such as roofing shingles, brick, building block,

plywood sheet or other manufactured building materials.Lumber transfer facilities may include open sided sheds or fully enclosed storage warehousing to provide protection from the elements, as well as open areas for simple ground storage.The site location should be level and well drained to facilitate movement of material handling equipment, as well as prevent damage to stored materials from standing water.Sufficient water flow and pressure from hydrants should be available for fire protection purposes.

#### 4.8.5.2 Steel Transfer

Steel handling facilities are designed for the transfer of semi-finished or finished steel products from railcar to truck or from railcar to short term ground or protected storage. Products may include structural shapes, slabs, billets, bar, tubular and pipe stock, as well as coiled sheet steel.

Steel transfer facilities may include open storage areas suitable for slabs, billets or structural shapes which are not affected by the elements or may be equipped with fully enclosed climate controlled warehousing for non-coated coiled sheet steel.

Vehicular travel areas should be paved with a suitable pavement material and section to support the heavy axle loading exerted by both material handling equipment and over the road truck operations.

#### 4.8.5.3 Equipment Transfer

Equipment transfer facilities can be designed to be temporary (for a specific project) or permanent (for local distribution). These facilities may handle mechanical process equipment, farm machinery, construction or mining equipment. These would typically be moved directly to a truck or stored in open storage areas until ground transportation moves them offsite. Some of these may require special ground transportation which will require consideration for truck and trailer routing through the facility. Loading or unloading may require cranes or drive on/off platforms or docks adjacent to the tracks.

#### 4.8.5.4 Wind Turbine or Power Pole Components

These facilities require special pads for unloading long and/or heavy equipment with large crawler cranes typically in tandem. These may be moved directly to trucks, but are typically stored onsite for later transport. This requires large suitable trafficable surfaces to operate the cranes as well as racks for storing turbine blades, nacelles and tower tubes. Ground transportation of these require over length trucks which will require particular attention to be paid with truck and trailer routing through the facility.

#### 4.8.5.5 Consumer Goods

Some of these consumer goods include large appliances, beverages, canned goods, home building materials (bricks, blocks, concrete pavers, etc). These will typically be moved in a box car or flat car so ramps, docks or larger forklifts will be required adjacent to the tracks.

#### 4.8.5.6 Railroad Track Components

These facilities will typically be located permanently at the manufacturing location and temporarily at the receiving location (construction site). The materials may include rail, cross ties (wood, steel, concrete, others), and other track materials. Permanent manufacturing locations may have specialized loading equipment but typically the receiving location will unload these materials with a grapple or forklift unless the railcars themselves have special equipment to perform this unloading function.

#### 4.8.5.7 Scrap Steel

These facilities will typically be located either in permanent locations such as those where truck loads are aggregated then loaded into gondolas and at receiving steel mills or in temporary locations where demolition is being completed in an industrial facility that has existing rail access. The environmental concerns of storing and processing scrap should be

considered, including good housekeeping practices in the storing and loading areas to prevent scrap from being tracked offsite or from contaminating storm water.

#### 4.8.5.8 Oil Extraction Transfer Facilities

These facilities will typically be located as close to the oil extraction process as possible to minimize trucking costs. These smaller non-Bulk facilities are typically built:

- for short term (before unit train facilities)
- before extraction area is fully proven (minimize investment)
- for single tenant

As the extraction area is more proven these facilities tend to diversify into other customers and commodities as larger unit train facilities are constructed and some products are shipped by unit train instead. These facilities typically handle the following commodities:

- Crude oil outbound to refinery or other aggregator
- Frac sand inbound and outbound
- Steel pipe inbound and outbound
- Oil extraction equipment (tanks, silos, etc).

### 4.8.6 RAILCAR TYPES (2019)

Transload Facilities will see a variety of railcars from common fleet cars to specialized purpose built railcars. The following is a list of potential railcars that may be used on transload facilities:

- Box car
- Centerbeam flat car
- Flexibeam flat car
- Bulkhead flat car
- Flat car
- Coil car
- Gondola
-

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# Part 5

# Locomotive Facilities[1]

## — 2016 —



## FOREWORD

The purpose of Part 5 is to facilitate the planning and design of yard layouts with respect to locomotive facilities. Detailed design recommendations of specific facilities are located in Chapter 6, Buildings and Support Facilities. The goal is to provide guidance on the efficient flow of traffic through the yard as it relates to locomotive facilities. This part presumes the railroad has selected a yard location on its rail network based on business needs.

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[1] References, Vol. 77, 1976, p. 87; Vol. 83, 1982, p. 363; Vol. 94, p. 123. Revised 1993.

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## SECTION 5.1 GENERAL

### 5.1.1 GENERAL CONSIDERATIONS (2016)

In designing a locomotive terminal layout a thorough study of the traffic and operating requirements of the terminal should be made jointly by the engineering, transportation and mechanical departments. This study should include consideration of the following data, keeping future expansion in mind:

a. Type(s) and size(s) of locomotives to be handled.

b. The level of service to be performed.

c. Number of locomotives handled in each direction daily.

d. Schedule of arrival and departure of locomotives.

e. Number of locomotives arriving during peak period.

f. Time within which locomotives arriving must be hostled.

g. Maximum number of locomotives in terminal concurrently.

h. Use by multiple railroads and passenger operators.

i. Number of locomotives repaired daily, by classes of work.

j. Number of locomotives under repair concurrently, by classes of work.

k. Amount of fuel issued, water consumed, lubricant consumed, sand consumed, and any other consumables, daily.

l. Number of staff required to operate the facility.

m. Turning locomotive consists.

n. Tax rates.

o. Manpower requirements.

p. Sustainability practices.

The following items should be considered in the placement of locomotive facilities:

a. Integration with existing infrastructure.

b. Segregation of locomotive facility trackage from other related yard or mainline movements.

c. Minimize reverse and conflicting movements.

d. Minimize power consist movement between locomotive facilities and receiving and departure tracks.

e. Future expansion or enhancement of facility.

### 5.1.2 SITE SELECTION (2016)

The site selection should include the following:

a. Costs of construction and operation.

b. Site history.

c. Site development.

d. Local permitting and zoning requirements.

e. Soil and foundation conditions.

f. Drainage, including existing and proposed.

g. Sewage disposal, and utilities (fire protection and domestic water, gas, electricity, storm sewer, industrial waste).

h. Relation to existing or proposed yards and to passenger and freight stations.

i. Availability of public firefighting capacity and nearby stations.

j. Potential environmental impact consideration.

### 5.1.3 TRACK LAYOUT (2016)

Track layout design should consider the following:

a. Flow of locomotive consists through the facility (it is preferable to enter at one end and leave from the other).

b. Entrance and exit tracks should be sized to provide for efficient movement and staging to support the progression of service and maintenance activities. This may include areas for pre-inspection, light servicing and quality assurance activities.

c. Sufficient tracks should be provided near the exit for holding serviced locomotives (also known as ready tracks).

d. The layout should provide at least one runaround track for flexibility of locomotive movement.

e. Escape tracks should be provided where possible.

f. A wye, turntable or loop track should be considered for turning locomotive consists.

g. Transfer tables.

h. A tail or pocket track to facilitate locomotive movement.

i. Track centers, track curvature, blue flag/derailment placement, at-grade crossings, insulated joints and turnout sizes.

j. Locomotive dimensions and specifications.

k. Tracks on which fuel or sand is to be loaded, unloaded or dispensed should have gradients as flat as possible, preferably not exceeding 0.08%.

l. Portions of tracks where fuel and sand cars are to be spotted for loading, unloading and where locomotives will be fueled should have tangent alignment. Preferably, curvature of supporting tracks should be 10 degrees or less.

## 5.1.4 BUILDINGS AND SUPPORT FACILITIES (2016)

Complete information on the design of shop buildings and other buildings required in an engine terminal, together with pits and other appurtenances, will be found in Chapter 6, Buildings and Support Facilities.

Yard layout should consider space and location requirements for the following:

a. Adequate office facilities.

b. Welfare facilities for facility employees, train crews, etc.

c. Crew change facility.

d. Storage for equipment, material and other consumables.

e. Infrastructure support buildings (pump house, compressor plant, generator, signal and telecommunication, tank farm).

f. Power service, lighting, and security.

g. Canopies may be considered over fueling and sand facilities to manage stormwater and control environment.

## 5.1.5 DESIGN CONSIDERATIONS (2016)

Items to be considered in the design of locomotive facilities:

a. Fire control system:

(1) Water storage tank.

(2) Various types of firefighting equipment, extinguishers, hydrants, monitor nozzles, etc.

(3) Special fire lanes.

(4) Emergency shut-off valves.

(5) Special storage areas for solvents, paints, etc.

(6) Spill containment around fuel tanks and other bulk flammable storage.

(7) Special fire protection systems and fire alarm systems.

b. Environmental Considerations:

(1) Industrial waste water collection, treatment and discharge.

(2) Stormwater.

(3) Handling of solid waste disposal.

(4) Noise ordinances and applicable regulations.

(5) Air emissions.

(6) Light ordinances and applicable regulations.

(7) Spill containment.

# SECTION 5.2 FUELING

## 5.2.1 GENERAL CONSIDERATIONS (2016)

At locations where locomotives are to be fueled, facilities must be provided for receiving, storing and dispensing the fuel, unless fueling is to be direct from tank truck to locomotive.

Diesel fuel may be delivered by rail tank car, truck, pipeline or boat.

If run-through trains are to be fueled, consideration should be given to locating a fueling facility on the main line or thoroughfare track at the crew change point.

Fueling may be performed at stationary facilities to which locomotives are moved, or by mobile servicing units, known as direct truck loading (DTL), which go to the locomotives.

## 5.2.2 TRACKS (2016)

Track(s) provided for fueling should have capacity equal to the typical diesel consist which is to be serviced at the facility.

Where diesel fuel is to be received by rail tank cars a separate unloading track should be provided with sufficient capacity for the largest cut of tank cars to be handled.

Consideration should be given to isolating tracks used for loading and unloading of fuels from static electricity.

A blue flag system should be considered on loading, unloading and servicing tracks.

## 5.2.3 STATIONARY FUELING FACILITIES (2016)

Stationary facilities will generally be operated by the railroad company, and incorporate several common elements, including but not limited to fuel pumping platforms with high-speed pumps, fuel storage tanks, and unloading, pumping and distribution facilities for the incoming fuel. At a stationary fueling facility, a train comes to the loading platform and the locomotives are spotted for fueling.

As a train arrives at the fueling platform the locomotive consist is positioned such that the fueling booms and hoses can reach all (or the greatest number of) locomotive fuel tanks.

A stationary fueling facility may incorporate other mechanical functions, such as 1,000 or 1,500 mile inspections and provisions for adding lube oil and water. Facilities for adding locomotive sand might be considered if operational constraints permit. Train crew supplies such as water may also be added.

Depending on the individual railroad's operations, it may be convenient to change train crews at the platform.

The following should be considered when selecting stationary fueling locations:

a. Proximity to pipelines and storage farms. Some railroads may have their own storage facilities that are filled by pipelines in rail terminals that have existing fueling capability.

b. Transportation from storage to delivery. Private roadways or branch pipelines to bring the fuel to the fueling pad may be justified.

c. Source reliability and redundant delivery options.

### 5.2.3.1 Main Line Fueling Facilities

a. General Considerations

Main line fueling facilities are installations for adding fuel to locomotives while they are still on their trains. Other servicing functions may be performed concurrently as capacity and convenience dictates. Main line fueling may be considered when schedule is important, or when there is no reason to take power off of the train to refuel, or to yard the train and refuel.

b. Operational Considerations

The number of locations and delivery time for fueling locomotives must be consistent with the schedules and characteristics of the railroad operations through the location.

(1) Each fueling track must be of sufficient length, clear of all other tracks and any public road crossings to permit the trains to be fueled without interfering with other concurrent activities, both of the railroad and of the public.

(2) The configuration should provide flexibility to perform other desired operations to a train as may be required. (e.g., access to inspect, add or remove cars or locomotives, etc., immediately prior to or following the actual fueling.)

(3) Consideration must be given to changing operations. Where practicable, room should be provided to allow for expansion. It is best to design the facility so that portions of it may be conveniently removed or restored to service depending on operational requirements.

(4) Wherever blue flag protection is dictated, provisions need to be made to place and remove these flags as efficiently and safely as possible.

(5) Consideration should be given to track centers to support the fueling platform equipment, train inspections, direct truck to locomotive fueling, and adjacent track roadway worker rules.

#### 5.2.3.2 Service Track Fueling Facilities

A service track facility is commonly located in the yard by a locomotive shop and has the same functionality of a mainline stationary facility but may have additional service capabilities such as an inspection pit, a sanding system, and accommodate scheduled locomotive inspections.

### 5.2.4 DIRECT TRUCK LOADING (DTL) (2016)

With DTL fueling the fuel comes to the locomotive. That is, a fuel truck pulls up next to the locomotive consist, and the fuel is transferred directly to the locomotive fuel tanks without the infrastructure requirements of a stationary fueling facility. DTL can be significantly more flexible than the stationary facilities, but does not have the delivery speed or capacity of the stationary facilities. Large access roads are required to accommodate fuel trucks. If the DTL facility utilizes trucks that do not need to leave railroad property and traverse public roadways, substantially larger volumes of fuel may be handled in each truck.

Comparison of DTL to Stationary Facilities

a. Stationary facilities can offer significantly higher loading speed and capacity.

b. DTL can offer much greater flexibility.

c. A hybrid of the two may offer the advantages of each, but would likely increase total cost above that of either alone. A hybrid may also be necessary to handle the fueling of remote or distributed power units (DPU).

d. Roadways to and from all DTL locations must be constructed to higher standards of curvature, strength and capacity than would roadways used solely for mechanized train inspection. High capacity, off-highway fuel trucks would require the most substantial roadways. Load ratings of public roads should be assessed to ensure they will accommodate DTL truck weights.

### 5.2.5 OTHER FUELS (2016)

It may be necessary at some locations to provide fuels other than diesel fuel, such as alcohol or natural gas. Such fuels require dedicated delivery systems and specialized fittings. In planning for a new fueling site, provision could be made for multiple fuels and delivery systems as required now or in the foreseeable future.

### 5.2.6 COMMON DESIGN CONSIDERATIONS (2016)

A number of factors must be considered when designing a fueling facility, regardless of type. Several of the significant factors are discussed below:

#### 5.2.6.1 Access to Fuel Tracks

a. Locomotives - Fueling tracks may be located on main tracks or on adjacent tracks. If fueling tracks are on or adjacent to main tracks, consideration must be given to the operational speed of the fueling tracks. The track geometry must allow trains to enter and leave at speeds that minimize the time in which the main track is fouled. The tracks must be long enough to clear the main track and accommodate safe train braking at the facility.

b. Vehicles - Vehicular access is vital to the fueling tracks. Roadways must be designed to accommodate the vehicles that will be delivering the fuel, both geometrically (turning radii and ground clearance for semi-tractor trailer trucks) and structurally (pavement type and thickness). For DTL, vehicular access must allow for the efficient movement of fueling vehicles and others requiring access during fueling operations. If two or more fuel trucks could be operated on the same roadway to access one or two trains, adequate width is needed for them to pass each other. Also, back-in moves between tracks should be minimized to the extent possible. To reach units within the train a flow-through truck

traffic pattern is necessary. This requirement may be an issue if a stationary fueling platform is located at one end of the space between the two tracks. In these cases it should be considered to have the DTL operation and stationary platform service location alternating between tracks to allow for both types of services.

#### 5.2.6.2 Fueling Track Length

The fueling tracks should be long enough to accommodate the longest train that is to be fueled without fouling other tracks or blocking other operations.

#### 5.2.6.3 Locomotive Consist Length

The length of the fueling area must consider the normal and maximum locomotive consist that is to be fueled.

#### 5.2.6.4 Fueling of Distributed Power

If distributed power is to be fueled, the designer must determine how it will be fueled. At a stationary facility it would be necessary to have a platform at each location where distributed power may be located throughout the train, or to move the train forward one or more times to spot distributed power at a single platform. In most operations, it is extremely difficult to predict the distance between the front of the train and any given distributed power locomotive unit. Thus, it would be necessary to provide long platforms to serve units located within the train, and significantly increase cost. If trains are to be re-spotted, sufficient fueling track length must extend beyond the platform to allow for the length of the longest train to pull forward to fuel the last locomotive units in that train. It may be preferable to use DTL to fuel one end of each distributed power train.

#### 5.2.6.5 Grade Crossings

Grade crossings should be avoided through the fueling tracks except for those necessary to support the fueling or locomotive servicing facility.

#### 5.2.6.6 Signal Considerations

Signal placement must be carefully considered with respect to fueling facilities.

A blue flag system should be considered on fueling tracks.

#### 5.2.6.7 Power Supply

The fueling facility should be sited such that commercial power is readily available. Generators should be considered for back-up power.

#### 5.2.6.8 Fire Protection and Prevention

See AREMA *Manual for Railway Engineering*, Chapter 14, Sections 1.5 and 1.6.

#### 5.2.6.9 Emissions

See AREMA *Manual for Railway Engineering*, Chapter 6, Article 4.9.2.

#### 5.2.6.10 Noise Pollution

See AREMA *Manual for Railway Engineering*, Chapter 6, Article 4.9.1.

#### 5.2.6.11 Track Structure

The track structure must be designed to accommodate full tonnage at track operating speed. There are several different approaches to the track structure and containment:

a. Direct fixation

b. Cross ties with track pans

#### 5.2.6.12 Clearances

Clearances for the facility must be in conformance with requirements of the carrier railroad and state regulations. See AREMA *Manual for Railway Engineering*, Chapter 28.

## SECTION 5.3 SANDING

### 5.3.1 GENERAL CONSIDERATIONS (2016)

Sanding facilities should be provided to serve all locomotives.

Sanding may be performed at stationary facilities or by mobile service vehicles. For design considerations for stationary facilities to unload, store and load sand into locomotives refer to Chapter 6, Buildings and Support Facilities, Part 6, Locomotive Sanding Facilities.

### 5.3.2 SITE SELECTION (2016)

Sanding facilities are usually situated adjacent to, and concurrent with, fuel and water facilities so that locomotives can be completely serviced at one location. If sanding facilities are co-located with the fuel and water facilities, the drainage system should include facilities to capture and remove sand from the industrial wastewater collection system.

### 5.3.3 TRACKS (2016)

A stand-alone locomotive sanding track should be provided with capacity not less than the largest locomotive consist normally operating in, or through, the terminal.

If locomotive sand is to be received in covered hoppers or other rail cars, a separate unloading track should be provided with sufficient capacity to hold the largest shipment.

If locomotive sand is to be received by truck, consideration should be given to receiving stations and roadways for truck movements.

A blue flag system should be considered.

# SECTION 5.4 INSPECTION PITS

## 5.4.1 GENERAL CONSIDERATIONS (2016)

Inspection pits may be located in a yard to support servicing and/or shop facilities. Inspection pits are often integrated into these facilities.

## 5.4.2 DESIGN CONSIDERATIONS (2016)

Items for consideration of stand-alone inspection pits:

a. Length not less than the longest locomotive to be inspected, plus the length needed for access stairs.

b. Welfare facilities.

c. Product storage.

d. Industrial waste collection, treatment and discharge.

e. Parking and roadway access.

f. A blue flag system.

g. Storage for equipment, material and other consumables.

h. Power service, lighting, and telecommunications.

# SECTION 5.5 LOCOMOTIVE SHOPS

## 5.5.1 GENERAL CONSIDERATIONS (2016)

The size of the building is determined by the length of locomotives and the number to be housed simultaneously. When locomotives are pooled, the back shop work will be done at one or more system shops, and the building for such work will generally be much larger and have more facilities than the building for running repairs at terminals located between such system shops.

The number and length of tracks should be sufficient to accommodate all of the locomotives to be housed at any one time. Stub-end heavy repair tracks may have certain economic advantages, and if such a layout is used there should be at least one through running repair track alongside of the heavy repair tracks. The desirable distance between track centers should not be less than 23 ft., which allows for a 12 ft. wide working platform. However, wider track centers are preferred.

## 5.5.2 DESIGN CONSIDERATIONS (2016)

Items for consideration of locomotive shops:

a. Wheel storage facilities adjacent to repair shops should be provided to assure a convenient supply of wheels, including wheels with their traction motors attached.

b. Deliveries by semi-trailer, pickups and couriers should be accommodated in and around the shop complex. Appropriate dock facilities should be considered.

c. Emergency response routes and fire lanes.

d. Material storage areas.

e. Product delivery, storage, and containment facilities.

f. Locomotive wash facilities positioned adjacent to or in-line with a locomotive shop.

g. Load testing stations on entrance and exit trackage.

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AREMA
AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION

# Part 6

# Passenger Facilities[1]

## – 2020 –

## FOREWORD

The designation "passenger facilities" as herein employed includes the platforms, platform canopies, tracks, passenger train yards and other accessory features necessary to conduct mass transit, suburban and intercity rail transportation. AREMA Committees 6, 11, and 14 collaborated to develop manual recommendations. Chapter 14 focuses on the layout and geometric considerations related tracks for passenger facilities. All other elements of passenger facilities are discussed in Chapter 6 and Chapter 11. For design criteria on railway passenger stations and other buildings, refer to Chapter 6, Buildings and Support Facilities. For design criteria on railway passenger platforms, refer to Chapter 11, Commuter and Intercity Rail Systems.

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[1] References, Vol. 77, 1976, p. 87; Vol. 86, 1985, p. 76. Rewritten 1985.

# SECTION 6.1 TERMINAL PLANNING

## 6.1.1 GENERAL (2015)

a. Studies for passenger facilities should be made by a team consisting of representatives from Engineering, Mechanical, Transportation, Passenger Service, Real Estate, Police, and other departments as required. Preferably the officer to be placed in charge of the new facility should also be a member.

b. Information should be gathered as to the intended use of the facility including projections for future years. Field investigations of terminal activities at sites similar to the proposed should be carried out to verify assumptions. Current literature should be reviewed to assure that the latest methods are utilized in design and construction. Team members should meet with representatives of railroads or agencies that have developed similar projects to exchange planning techniques and to look for ways of avoiding problems encountered.

c. Terminal design criteria should be established for each element. Key design inputs include frequency of train movements, number of passengers arriving per hour (peak), average baggage count, gross ticket sales, and retail revenue per square foot of space. Regional Planning Agencies are good source of data on population densities, travel patterns, etc.

d. Good design practice:

(1) Design platforms to appropriate width.

(2) Provide appropriate routing of passengers to and from platforms to avoid temptation to cross tracks.

(3) Provide flexibility to add or extend platforms in the future.

e. Additional Considerations:

(1) Will trains run-through or terminate?

(2) What is the proposed mix of trains?

(3) Will commuter and intercity trains use the same platforms? Each has different dwell time characteristics;

(4) How will variations in rolling stock, and dwell time impact design?

(5) Where and how will trains be yarded?

(6) How will proposed operations impact terminal capacity?

(7) What type of facility is required for crew on duty and layover?

(8) Will air rights development be considered? If so, must ensure that air quality is addressed for both passenger and crews.

(9) Homeland Security elements required in the design - i.e., passenger screening; video surveillance; restrictions on trash receptacles, etc.

f. Operation of passenger service in North America has in all but a few situations been assumed by government agencies, public supported corporations, or special departments within private carriers in order to isolate the attendant costs of providing such service. As a result, new passenger station facilities are publicly funded as distinct from facilities

required for freight operations. Team members should be aware of the restrictions on such funding and allow adequate time for the various approvals involved.

g. A passenger terminal should be so located and designed as to coordinate as far as reasonably practicable with other civic activities. It is often desirable to make general civic improvements at the same time the terminal is being constructed. Modification of street approaches is almost always involved. The costs should be assumed by the parties benefited. Close cooperation between the terminal team, the planning board and executive officers of the municipality, and perhaps other civic groups, is necessary in order that any new legislation as may be necessary shall be fair and equitable to all.

h. Considerations must be given to accessibility for persons with disabilities. A number of factors are to be considered. A thorough review of guidelines of the Americans with Disabilities Act (ADA) should be completed during the planning process to ensure that the proposed facility will comply with ADA guidelines and regulations as required.

## SECTION 6.2 STATION ENVIRONMENT

### 6.2.1 GENERAL (2015)

a. The station environment includes all facilities required for the complete accommodation of passengers and their belongings between public entrances and the trains. The station typically includes the main building, connecting concourses, platform access, platforms, parking and station approaches.

b. The location of the station should be determined by the economic balance among the following factors:

(1) Proximity to and ease of approach from all associated rail lines, without excessive curvature or gradient, and preferably without grade crossings.

(2) Proximity to yard, support facilities, and layover locations (downtown and outlying facilities are required for commuter services).

(3) Ability to develop (or access to existing) support facilities.

(4) Accessibility to business and civic activities and other modes of transportation.

(5) Land values and land use.

(6) Cost of construction.

(7) Size and shape of available real estate.

(8) Possible need for future expansion.

c. Factors to consider when designing a station that will be used by connecting intercity passengers include:

(1) Transfer passengers occupy a station for a longer length of time and require more extensive facilities per passenger than commuter or through passengers.

(2) Reducing the time interval between incoming and outgoing trains decreases requirements per passenger for waiting room space and for certain other facilities.

(3) The number of passengers handled during the rush hour does not alone determine the size or number of facilities required. Local conditions must be studied, as they affect requirements for any particular situation.

(4) The size or number of facilities must be modified to make allowance for the time of arriving and departing trains and the span in minutes between them; the ratio between passengers commencing or terminating their journey and transfer passengers; number of hold over passengers arriving or departing outside of the rush hour but occupying space and requiring service during a portion of the rush hour; and the departure from a reasonably uniform spread of passengers entering and departing within the rush hour.

d. Factors to consider when designing a station that will be used by suburban commuters:

(1) Suburban passengers occupy a station for a minimum length of time and move faster than the through passenger and therefore requirements in the way of station facilities per passenger are substantially less.

(2) When suburban business is heavy, it is desirable to separate the through and suburban service, as their requirements are not similar. This may be done by handling the two classes of service at different levels different sides or ends of the station; or different stations, one beyond the other.

(3) Indicator boards are the only directional information required, as a rule, by commuters. They should show track number, scheduled leaving time, and essential identification of the trains.

e. Factors to consider when rehabilitating or moving existing stations:

(1) Railroad stations have previously been an important element of communities serviced by railroads. Often, the railroad station was the focal point of the community.

(2) In order for the railroads to effectively and actively compete in the transportation marketplace, they must have efficient comfortable stations and station environments.

(3) Station environments should be created to cause the using passenger to enjoy and be comfortable in the facility.

(4) Station environments must be designed with enough flexibility to meet changing travel patterns. They must be easily expandable when ridership levels show marked increases.

f. When designing any passenger facility the designer must realize that it is subject to vicissitudes of weather, delays and derailments to trains, late connections, power failures, surges in traffic, bad order equipment, special trains or cars requiring special handling, excursion travel, conventions, and special functions at irregular periods.

### 6.2.2 ACTIVITIES (2015)

The station activities that tracks and track configuration may have to support include, but are not limited to:

a. Loading and unloading of passengers.

b. Loading and unloading of baggage.

c. Adding or removing cars and/or locomotives.

d. Setting out defective equipment.

e. Lay-over of trains and equipment.

f. Fueling and minor servicing of cars and locomotives.

### 6.2.3 TRACK (2020)

a. The track layout at any station should be designed to accommodate the planned schedule of trains stopping at that station, trains passing through it, sections combining or splitting, special cars on or off, locomotive changes, delayed trains, special movements, and future increases in traffic. The track layout should not be solely designed around a specific timetable, since train schedules can be altered very quickly.

b. Sufficient lead tracks should be provided to permit at least two simultaneous parallel movements. The track layout should be sufficiently flexible to provide for complete interchange of routes. A ratio of three station tracks to one lead track should be adequate if the lead is properly designed.

c. The track layout should be designed with the length between turnouts as required for the proper signal indications and necessary clearances for operation of track circuits so that a system of fixed signals or interlocking may be installed whenever desired without restricting the use of any of the routes or the necessity of additional track changes.

d. The number of station tracks should be determined by the schedule of trains and switching desired; allowances for delayed or special trains, schedules changes, and future expansion; layover time and the proximity of the passenger yard; track lengths available; and the type of operation used. Servicing may be performed in the station when a maintenance facility is not available.

e. The track length is determined by the size of the consists operated, the maximum platform length required, and allowances for flexibility in the assignment of tracks for the longest trains.

f. Through track stations are preferred to stub track stations from an operational standpoint. Loop tracks are preferable to wyes and generally expedite service at terminal points when nonreversible equipment is used.

g. Freight or industry connections on the station approach tracks or on lines within or adjacent to the terminal zones should be arranged to avoid or minimize interference with passenger train traffic.

h. It is generally acceptable at stations where dwell time is less than 10 minutes to provide platforms adjacent to the main line trackage. Where other activities such as section splits occur, a separate station track is usually necessary.

i. At stations where freight movements are anticipated through the station area, dedicated freight tracks or freight mains should be considered to minimize conflicts between freight and passenger operations, such as at platforms where the loading/unloading of passengers is performed.

j. When a station is on a rail line that carries freight and passengers, and high-level platforms are required, it will be necessary to provide a separate station track, as the high level platforms do not accommodate the horizontal clearances required for freight operations.

k. When a new station site is being considered, it is preferred that the station and platforms be located on tangent track to provide the best visibility for passengers and train crews and avoid excessive gaps between high-level platforms and equipment.

l. Track grades adjacent to platforms should be as flat as possible.

m. The station site should be well drained.

n. There should be no grade crossings within the limit of the proposed platforms, or for approximately 500 feet beyond each platform end.

o. Station tracks should be designed with the ability to accommodate future expansion of train length when possible.

p. Station environment must accommodate placement of signals in stations, or rules must require operation at restricted speed until the next signal can be seen.

q. When stations are expected to operate with high volumes of ridership or adjacent to high ADT roads, grade separations are recommended.

r. Tracks in multiple track stations should be spaced such that intertrack fencing can be installed without the need to provide flaggers when maintenance is performed on adjacent tracks.

## SECTION 6.3 PASSENGER TRAIN YARDS

### 6.3.1 GENERAL (2015)

a. It is desirable that a single coach yard and its associated facilities for car inspecting, repairing, cleaning, watering and stocking be an integral feature of every large passenger terminal, whether or not more than one railway is accommodated. It is definitely preferable to have all coach switching performed by and under full control of the terminal management either as a joint operation or as a separate company. Separate facilities may be provided for particular trains or types of equipment, although the servicing of all passenger train equipment in a single yard is preferable.

b. The location of a coach yard should be determined by the economic balance among the following factors:

(1) Available sites.

(2) Land values.

(3) Cost of construction.

(4) Proximity to the station and other facilities.

(5) Nearby utilities.

(6) Cost of moving equipment between station, coach yard and engine house.

(7) Possible need for future expansion.

c. The capacity required in a coach yard depends upon:

(1) Number of cars and trains to be handled.

(2) Type of equipment.

(3) Level of maintenance.

(4) Schedule of equipment layover.

(5) Frequency of cleaning.

d. The ability to secure the proposed yard against trespassers to reduce theft and vandalism should be considered.

## 6.3.2 ACTIVITIES (2015)

The yard activities that tracks and track configuration have to support may include, but are not limited to:

a. Lay-over of trains and equipment.

b. Storage of cars and locomotives.

c. Cleaning of cars and locomotives.

d. Restroom and toilet cleaning and servicing.

e. Switching and handling of trains.

f. Repair of cars and locomotives.

g. Fueling and inspection of equipment.

h. Welfare and layover facilities for crews.

## 6.3.3 TRACKS (2015)

a. There are two general types of coach yard layouts: Stub track and through track. Through track yards may be operated as two systems of stub tracks. Operation is most efficient in a system of through tracks.

b. Tracks of equal length and equal to the length of the longest trains provide the greatest operating efficiency.

c. An alternating spacing of 28 feet/20 feet between track centers is desirable for tracks on which car and locomotive servicing work is done. This allows service vehicles to pass each other on the wide platform and utilities to be centralized on the narrow platform. Where platforms between tracks are obstructed by supports to overhead service lines, brake shoe racks or above-platform service outlets, such obstructions should be located off center of platforms to provide a wider passageway on one side. Obstructions may require increasing the track centers to allow service vehicles to clear. Obstructions must be located so that they do not foul minimum State clearance requirements. Utility equipment should be placed on the narrow platform at convenient locations.

d. Tracks used for storage of extra cars do not require particularly wide spacing or any special car servicing features other than utilities necessary to support the car's equipment while idle.

e. Tracks with wide centers are usually arranged in groups at the leads to facilitate switching. Auxiliary leads and tail tracks of ample length should be provided.

f. Curvature of tracks should not be less than 450 feet radius through turnouts or otherwise. Make-up tracks should be as straight as practicable to afford long sight lines for operating crews.

g. Tracks should be placed on as nearly a level gradient as possible.

h. A wye or loop track should be provided for turning equipment. Movements on a loop track are more expeditious and are preferred.

i. Special tracks for making up or breaking up trains are sometimes required.

j. Only light or running repairs are normally made in a service yard. Cars needing additional work are usually switched to a Car Shop.

k. Yards must be well drained.

l. In the interests of cleanliness, sanitation, and possible reduced maintenance expense, consideration should be given to track constructed on longitudinal concrete slabs with paving between slabs to present a completely paved area which can be washed. Such construction is particularly desirable for tracks at commissary platforms or on which diners are restocked.

m. Yard trackage is the most inflexible item in a yard. Due to severe curve and grade restrictions, all buildings and utilities should be located after the necessary track and leads are designed.

n. Where tracks will be surrounded by platforms, consideration should be given to the use of concrete ties as any future tie removal will be very complicated.

o. In regions with significant snow fall, locations for snow storage or alternative means of snow removal/disposal should be considered.

p. When proposed consists will include locomotives, additional considerations are appropriate. Fueling, inspection, collection of sanitary holding tanks, and collection of retained fluid tanks are all functions that may have to be accommodated.

## SECTION 6.4 UTILITIES

### 6.4.1 MECHANICAL SYSTEMS (1985) R(2015)

a. Steam standby connections, if needed, should be provided at all tracks on which cars will stand without a locomotive attached. For stub tracks, steam connections should be located at the ends, one connection for each track. For through tracks they should be placed to serve each track at the point or points where the rear of a train would normally be placed and an inside derail protection when in yards. Pressure of 125 lb delivered through a 2-1/2 inch connection is standard. Appropriate control and bleed valves should be provided. Locomotive boiler water facilities may also be needed if steam generators are utilized. Steam may also be used for thawing, cleaning, and heating. Due to rapid pipe deterioration, steam lines should normally be built above ground or in accessible underground tunnels. Steam pipes must be anchored and thermal expansion controlled through the use of expansion joints or loops.

b. Compressed air connections should be provided at all tracks where the method of operation or servicing requires that an air brake test be made while the train is standing without locomotive attached. Air pressure should be between 120 and 140 lb and be delivered through 1-1/2 connection with appropriate control and bleed valves. Compressed air may also be used for cleaning and portable tools. If used in this manner, connections of 3/4 inch size should be distributed as needed so that no more than 100 feet of hose is normally necessary. Tool outlets should be provided with a regulator to reduce pressure to match tool working pressures.

c. Natural gas may be used for building heating. Pipe routing should be shown on site plans and the pipe identified at convenient intervals. Appropriate measures should be taken to ensure that if a pipe is ruptured the utility involved can be notified as soon as possible. These measures would include ready availability of pipe plans, utility phone contacts, and easy accessibility to shut off valves.

d. At yards or stations where train equipment may be watered, hydrants spaced two car lengths apart, preferably serving two tracks, should be provided. Where station dwell time is short, hydrants may be spaced for every car. Water service should be distributed so that no more than 100 feet of hose is necessary to reach a car. Water hydrants in yards are usually placed on alternating platforms allowing service vehicles an unobstructed path on non-utility platforms. Freeze protection should be applied where necessary. If backflow preventers are required, a heated cabinet is preferable. A potable connection of 1 inch size should be provided for car watering and a minimum 3/4 inch non-potable connection

may be used for washing purposes. By looping and interconnecting water pipes, a better flow pattern can be a achieved. Adequate control valves should be installed to allow sections to be taken out of service without affecting all operations.

e. Adequate drainage should be provided to drain track structures, catch paved area runoff, and collect roof drainage. Where necessary, piping should be separated to allow for treatment of polluted wastes. Sanitary drainage should be kept separate until delivered to city facilities, if available.

f. Pipe lines may be installed for fuel oil, lube oil, sand, cleaners, foam, and other specialized products. These and all other pipe lines should be identified at adequate intervals. A spill prevention plan is usually necessary for such installation.

## 6.4.2 ELECTRICAL SYSTEMS (2004) R(2015)

a. Adequate power supply should be designed to handle current needs with at least 50% available for expansion, if anticipated. Building supply of 480V/277V is common along with 208V/120V systems. Where required, head end train standby should be provided at the end of the platform corresponding to the end of the train not subject to switching. Modern North American systems provide 480V 3 ϕ standby for train power. Amperes of 400, 800, and 1600 are standard. Recording ammeters are useful in determining consist power requirements. Equipment and climate variations preclude the use of universal sizing by train length. See Chapter 33, Electrical Energy Utilization for more information. Older 240V 3 ϕ 100 amp standby may also be provided for steam heated equipment with outlets provided so that no more than 100 feet of cable is necessary to reach each car. Convenience outlets of 120V may be provided where necessary such that cord lengths do not exceed 200 feet. Electric vehicle charging stands should be located so as not to disrupt operations while vehicle is being charged. Emergency platform standby power systems should be considered. Block heater outlets are necessary in parking lots in certain areas of extreme cold. Electrical power may also be required to support the needs of trains equipped with Head End Power (HEP).

b. Platform lighting should be provided at a minimum 20 foot candle level. Parking lot illumination should be a minimum of 5 foot candles. Walkways, entrances and signage should be lit at an appropriate level taking into consideration adjacent lighting and security requirements.

c. Telephone service should be provided as needed. A trunking capability of at least three times current use should be requested to ensure easy future expansion, if anticipated. Consideration should be given to interconnecting telephone and other company communication systems to allow for faster information flow. Platform jacks may be provided to permit the connection of train telephone systems.

d. Yard lighting should be provided where work at night is common or security is desired. A 5 foot candle minimum will generally provide acceptable night lighting. Lights should be mounted as high as possible to reduce shadowing between cars. High pressure sodium lighting is currently the most energy efficient source although it does alter color perception. Mercury vapor or metal halide lighting should be used if color perception is important.

e. Train status reporting systems covering waiting rooms, gates, and platforms should be provided as required. Equipment ranges from simple moveable sign boards to elaborate video and flip-sign systems where the entire system is interfaced with the train operations.

f. Public address, intercom, talk-back, and message tube systems may be included in yards. They speed problem resolution and increase security. Public address systems should be provided to reach all station areas including the platforms. Microphones or telephone deluxe paging may be used to initiate announcements. By designing such facilities in advance, wires can be installed underground avoiding weather and vehicle contact. Particular care should be used when determining control and terminal locations to avoid conflicts between operating hours of those locations and other users. Spare ducts should be provided in all duct banks, where possible, for future expansion.

g. Adequate conduit should be provided in buildings to carry radio antenna wires to the roof. As the FCC limits the number of broadcast stations in a close area, consideration should be given to remote base stations when needed. Radio

antennas should be located so as not to detract from the facility but allow clear coverage to the entire site. See Chapter 6, Buildings and Support Facilities for roof penetration information.

h. Signal, fare control, computer, fire, security, and alarm systems should be designed carefully in advance of construction on a master plan to avoid overhead wires and afterthought appearances. Video cameras can be used for security, car observation, drawbridge control, and to improve existing sight lines. Since they require power, an adequate source must be identified before locations are committed. Signal systems, when present, should be interfaced with yard operations to avoid excessive radio or intercom use.

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# Glossary

## – 2019 –

The following Terms are used in the various Parts of Chapter 14 Yards and Terminals and are defined here. These definitions apply only to those Parts in which they are cited as Terms since they may have different meanings where used in other Parts. Textbook definitions of all terms included in the Chapter are not included in the Glossary as it is assumed that engineering professionals are the intended users of the Manual; however, some basic terms were included in the belief that they may be less commonly used by engineers with less railroad-related experience.

### Advance Tracks

A track somewhat longer than the maximum train length, or freight main tracks extending to or beyond the outside of the yard, in either direction Term cited in 2.3.6.5a.

### Block Swap

A group of cars heading to the same destination is called a block. The operation where a block is placed in a siding or yard track to be exchanged between trains or operators is known as the swap. Block swaps may include exchanging crews, and/or road power.

### Body tracks

*Synonyms: Bowl track or Class track.* Parallel tracks in a railroad yard upon which cars are switched or stored. Term cited in Figure 14-2-1 and 2.5.3.1b.

### Car Throughput

The rate at which cars will be expected to be processed through the classification yard. Term cited in 2.4.5.4.

### Double yard

A double yard has two separate classification body track areas and switching ladders to handle each direction of traffic separately. Term cited in 2.3.2.

### Drilling

*Synonyms: Switching.* The back and forth motion of locomotives and cars during switching operations. Term cited in 2.4.5.3.

### Flat Yard

A yard where cars are moved by a locomotive on relatively level tracks as opposed to over a hump.

### Gravity / Hump yard

A classification yard where the classification of cars is accomplished by pushing them over a summit, known as a "hump", beyond which they move by gravity into their assigned track. Term cited in 2.3.2 and 2.4.1

## Kicking

Uncoupling cars from the switching locomotive while in motion, allowing the cars to roll freely to other rail cars where they are expected to couple upon impact.

## Ladder tracks

A lead track in which turnouts (switches) are placed connecting successive body tracks in a railroad yard. Term cited in 2.4.1b, 2.5.3.1c, 2.7.2.3 and 2.7.2.4.

## Local yard

A yard intended to handle local traffic within a larger classification yard complex. Term cited in 2.4.1b, 2.5.3.1c, 2.7.2.3 and 2.7.2.4.

## Marine Dock

A marine structure at which ships or barges are moored. A dock constructe4d parallel to the shoreline is typically called a "wharf", while a dock constructed at an angle, ranging from acute to right to the shoreline, is called a "pier". Term cited in 4.1.3.1.

## Material Supply Tracks

Tracks for Stores and Maintenance-of-Way departments. Term cited in 2.3.6.5f.

## Pin-Puller

A railroad employee responsible for uncoupling cars. Term cited in 2.4.1g.

## Point Protection

Crew member on or observing movement of the lead car in the direction of movement. Term cited in 2.7.3.

## Recommended Practice

A material, device, design, plan, specification, principle or practice recommended to the railways for use as required, either exactly as presented or with such modifications as may be necessary or desirable to meet the needs of individual railways, but in either event, with a view to promoting efficiency and economy in the location, construction, operation or maintenance of railways. It is not intended to imply that other practices may not be equally acceptable. Term cited in Foreword, footnote 1.

## Remote Control Zone

One or more tracks within defined limits, within which remote control locomotives, under certain circumstances, may be operated without an employee assigned to protect the pull-out end of the remote control movement, i.e., the end on which the locomotive is located. Term cited in 2.7.3.1 and 2.7.3.3.

## Retarder

A braking device built into a track to reduce the speed of rolling cars. Examples are Powered, Inert, Hydraulic and Pneumatic Retarders. Term cited in 2.3.6.5e, 2.4.1.t(2), 2.4.3.2c and 2.4.5.3.

## Scale Track

A track fitted with a scale mechanism to permit the weighing of cars. Term cited in 2.3.6.5c.

## Shove Indicators

*Synonyms: Clearance Indicators.* A signal indicator used to convey the distance to the clear point or stopping point along a track, or to convey to yard operators instances of cars moving beyond the clearance point on a track. Term cited in 2.3.3f.

## Shoving

Moving cars into a body track where they are not uncoupled from the switching locomotive until they have been coupled to other cars in the body track. Term cited in 2.3.3f.

## Standard Lead Ladder

Ladder tracks arranged such that the angle of the turnout does not change. Term cited in 2.6.5.1.

## Storage tracks

Tracks to ease yard operations where many cars are held to supply local industries or on-line customers. Term cited in 2.3.6.5d.

## Switching lead

*Synonyms: drill track, pullback, trim track or yard lead.* A length of track ahead of the ladder track where cars are pulled out of a yard (body) track and placed into another yard track. Ideally, this track is longer than longest yard track. Term cited in 2.3.6.2, 2.7.2.1, 2.7.2.3 and 2.7.3.1.

## Tandem Ladder

Ladder tracks arranged such that the angle of the turnout is doubled. This arrangement creates internal switches. Term cited in 2.5.4.2.

## Tandem turnout

*Synonyms: inside switch.* Used in a tandem ladder. The second of two turnouts, where the first turnout comes off the ladder track and the second turnout comes off the track created by the first turnout. Typically, the switch ties (head block ties) cross under the ladder track. Term cited in 2.5.4.2.

## Thoroughfare tracks

Tracks normally kept free of standing cars for use in moving locomotives and cars from one end of a yard to the other without fouling the main tracks. Term cited in 2.3.6.5b.

## Yard Air

Used on freight cars that are disconnected from the locomotive to maintain air pressure and permit the testing of air brake equipment.Term cited in 2.3.3e and 2.6.5.4.

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# References

The following list of references used in Chapter 14, Yards and Terminals is placed here in alphabetical order for your convenience.

1. *Assessment of Classification Yard Speed Control Systems*, SRI.

2. *Innovation in Classification Yard Technology*, TRB record 927, 1983.

3. *Proceedings of the Second Workshop for Classification Yard Technology*, May 1981, report FRA/ORD-81/41.

4. *Proceedings of the Workshop for Classification Yard Technology*, May 1980, report FRA/ORD-80/17.

5. *Railroad Classification Yard Technology Manual*, FRA/ORD-81/20 I, II and III.

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