NCFRP

REPORT 11

NATIONAL
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Truck Drayage Productivity Guide

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM

NCFRP REPORT 11

Truck Drayage Productivity Guide

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NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM

America's freight transportation system makes critical contributions to the nation's economy, security, and quality of life. The freight transportation system in the United States is a complex, decentralized, and dynamic network of private and public entities, involving all modes of transportation—trucking, rail, waterways, air, and pipelines. In recent years, the demand for freight transportation service has been increasing fueled by growth in international trade; however, bottlenecks or congestion points in the system are exposing the inadequacies of current infrastructure and operations to meet the growing demand for freight. Strategic operational and investment decisions by governments at all levels will be necessary to maintain freight system performance, and will in turn require sound technical guidance based on research.

The National Cooperative Freight Research Program (NCFRP) is a cooperative research program sponsored by the Research and Innovative Technology Administration (RITA) under Grant No. DTOS59-06-G-00039 and administered by the Transportation Research Board (TRB). The program was authorized in 2005 with the passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). On September 6, 2006, a contract to begin work was executed between RITA and The National Academies. The NCFRP will carry out applied research on problems facing the freight industry that are not being adequately addressed by existing research programs.

Program guidance is provided by an Oversight Committee comprised of a representative cross section of freight stakeholders appointed by the National Research Council of The National Academies. The NCFRP Oversight Committee meets annually to formulate the research program by identifying the highest priority projects and defining funding levels and expected products. Research problem statements recommending research needs for consideration by the Oversight Committee are solicited annually, but may be submitted to TRB at any time. Each selected project is assigned to a panel, appointed by TRB, which provides technical guidance and counsel throughout the life of the project. Heavy emphasis is placed on including members representing the intended users of the research products.

The NCFRP will produce a series of research reports and other products such as guidebooks for practitioners. Primary emphasis will be placed on disseminating NCFRP results to the intended end-users of the research: freight shippers and carriers, service providers, suppliers, and public officials.

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FOREWORD

By William C. Rogers
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NCFRP Report 11: Truck Drayage Productivity Guide presents a compendium of metrics designed to give port authorities, marine terminal operators, drayage firms, and regional transportation planners the tools to improve drayage productivity and capacity while reducing emissions, costs, and port-area congestion at deepwater ports throughout the United States. The guide is especially valuable because of the variety of evidence-based research methods (including gate camera analysis, analysis of transaction databases, and automated vehicle location geofencing techniques) used to identify and quantify the impact of inefficiencies in port drayage. The guide identifies and quantifies the impacts of bottlenecks, associated gate processes, exceptions (trouble tickets), chassis logistics, congestion, and disruption at marine container terminals. The impacts are described in terms of hours, costs, and emissions that were estimated using the Environmental Protection Agency's DrayFLEET model.

The guide, with an accompanying CD-ROM containing the contractor's final report and appendices (unedited by TRB), includes a set of recommendations for industry stakeholders (i.e., shippers, receivers, draymen, marine terminal operators, ocean carriers, and port authorities) designed to address inefficiencies, control costs, and reduce associated environmental impacts of truck drayage.

Truck drayage is an integral part of the intermodal freight transportation system. The most visible drayage sector is at seaports, where dray drivers spend a considerable amount of time waiting to enter marine terminals and then often operate in non-productive ways while inside the terminal gate. This leads to increased truck idling, resulting in air pollution and congestion on the roads leading into terminals. Diesel emissions from idling trucks are a serious health concern for communities adjacent to seaports, especially deepwater ports. In 2006, the Waterfront Coalition held a series of workshops to examine this problem. The conclusions reached at the workshops were that there are numerous inefficiencies in the drayage system that could be corrected if the parties had a better understanding of the time drayage truck drivers spend queuing to enter marine terminals and the locations of bottlenecks in terminal operations. However, until now there has only been anecdotal information from drayage truck drivers about the length of time they spend in queues outside the terminal gates and the underlying causes of delay.

Under NCFRP Project 14, the Tioga Group, with the assistance of the University of Texas at Austin Center for Transportation Research and the University of South Carolina Department of Civil and Environmental Engineering, was asked to (1) use evidence-based research methods, as well as truck driver surveys, to identify and quantify bottlenecks within marine terminals and (2) develop a guidebook that identifies potential metrics for truck drayage productivity and improvements that stakeholders can make to increase throughput, reduce emissions, improve freight mobility, and increase driver productivity at marine terminals nationwide.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

CHAPTER 1

Introduction

Overview of Port Drayage

Containerized shipping links trading partners through a sequence of land, sea, and terminal operations. The performance of containerized shipping as a whole depends critically on intermodal drayage—the trucking movements linking marine terminals with importers, exporters, and rail terminals. Containerized shipping is a hub-and-spoke system, with the ports and terminals as the hubs and drayage providing the spokes. This role makes drayage the chief manifestation of containerized shipping in port area communities, where it is a part of the congestion and emissions problems endemic to urban areas.

Port drayage refers to the movement of containers between a port terminal and an inland distribution point or rail terminal. A typical drayage assignment involves either delivering an export container to a marine terminal or picking up an import container. The complexities of the business, however, require an average of around 2.5 drayage trip legs for each container moved—slightly more than one round trip—due to the need for tractor-only moves and empty container repositioning. This average implies that for about 26 million containers handled at U.S. ports in the peak year of 2007, truckers drove over 60 million trip legs.

Drayage of marine containers to and from port terminals is a complex process involving interactions between customers (importers, exporters, third-party logistics firms [3PLs]), ocean carriers, terminal operators, and trucking firms. The fundamental business transaction is between the ocean carrier and the customer, with the customer paying for waterborne transportation of the goods inside the container. Marine terminal operations and drayage are both intermediate steps, and both must cope with the movement preferences, policies, and capabilities of the ocean carriers and their customers. This intermediate position requires both drayage firms and marine terminals to cope continually with unevenness of demand, inconsistent priorities, mismatched information flows, and cost pressure.

In any given port region, containerized trade involves a handful of large marine terminals, up to about 30 steamship lines, 2 to 3 railroads, and hundreds of small drayage companies. The typical trucking company specializing in port drayage relies heavily on owner-operators as sub-haulers, operating under contract with the drayage company providing dispatching, management, and commercial functions. Some firms also have company (employee) drivers. Drayage companies can be a single-owner operator but most of the business is done by small firms with 10 to 100 drivers.

The drayage process is initiated by a transaction between a carrier and a customer for the conveyance of goods. The drayage firm usually acts as a third party that is neither the customer nor the ocean carrier. Drayage firms typically receive little advance notice of an order. For import traffic, trucks are dispatched to the terminal at some point after the container clears customs yet prior to the time in which the cargo owner will have to pay demurrage charges. The period of free storage varies by terminal but is rarely more than 1 week. For exports, deliveries can be made within a predetermined window prior to vessel departure. The principal challenge for the dispatcher is to allocate resources (trucks) across orders in a way that keeps all trucks working productively while still meeting the delivery windows of the customers, which can vary based on the customer demands and commodity type. Truckers, who are paid per load, rely on dispatchers to ensure that their assigned daily schedule minimizes the number of miles they drive without a load and the time they spend waiting for a load to be ready.

A key challenge facing drayage companies is matching up the movement preferences of importers and exporters with the protocols and capabilities of marine terminals and ocean carriers. This challenge creates a constantly shifting set of complex and often contradictory requirements. Drayage companies and their drivers are remarkably adaptable, but the complexity of their task leads to inefficiencies, delays, excess costs, and unnecessary emissions. Identifying and reducing these inefficiencies is a major objective of this guidebook.

The drayage industry is fragmented and highly competitive. The competitiveness leads drayage firms to relentlessly pursue efficiencies and cost-cutting opportunities. Most drivers are owner-operators who receive a percentage of the revenue from each move rather than being paid by the hour or the mile. Drivers therefore have an incentive to make as many revenue moves as possible and minimize non-revenue time and miles, accounting for much of the practices observed in the industry. The fragmentation of the system, however, limits the ability of any one firm to optimize operations, manage peaking, reuse empty containers, or otherwise rationalize the system as a whole.

Drayage companies and owner-operators typically rely on Class 8 diesel tractors (Figure 1–1) purchased after they were retired from long-haul trucking companies. The result is an older heterogeneous fleet of equipment originally designed for other uses. Some companies and owner-operators do buy or lease new tractors with specifications suitable for port drayage. That practice has increased greatly in Southern California due to the requirements of the ports' Clean Truck Program. The practice is likely to spread as other ports eventually implement their own clean air plans.

The focus of this guidebook is helping planners better understand the causes of bottlenecks, delays, and extra trips that increase the time, cost, emissions, and congestion impacts of port drayage beyond what is necessary to accomplish the underlying transportation task. The guidebook does not venture to instruct planners in how to eliminate all congestion from the port system.

Source: The Tioga Group, Inc.

Figure 1–1. Class 8 drayage tractors.

Instead, the guidebook focuses on strategies for identifying and quantifying what can be considered "normal" congestion that reflects a well-utilized terminal and differentiating this from bottlenecks, cascading delays, or redundant dray trips that hold down the efficiency of a terminal and the productivity of drayage truckers. This distinction between these two categories is rarely clear and depends, to a certain extent, on the perspective of the participants.

Congestion and delay at marine terminal gate queues and container yards is primarily caused by peaking, and can be exacerbated by limitations on working hours, external factors such as the OffPeak Program, or shortcomings of legacy facilities. There will always be comparative peaks in demand, regardless of volume. Even if a terminal is running under capacity, it will usually have peak periods where the volume temporarily exceeds the allocated labor. Most peaks follow recurring patterns known to port staff. Beyond congestion within the terminal, congestion on urban streets and highways is ordinarily beyond the control of terminals or truckers, but port authorities may have some influence. Extended gate hours (early morning and late evening) do, however, assist truckers in avoiding the worst peak traffic hours.

Even with the most meticulous preparation, there is no such thing as a problem-free system. Drayage is a part of a complex international trading system in which occasional miscommunications between parties are a part of doing business. Errors in paperwork, for example, may not be the fault of the drayage driver, yet they can still cause delays for the driver and the drayage system. Every participant expects periodic congestion due to the ebb-and-flow nature of the business. Accordingly, the study team attempted to determine the frequency and causes of unexpected or unexpectedly severe delays, unnecessary bottlenecks, and wasteful extra trips, and to identify best practices to reduce those problems.

Despite their local orientation, drayage operations are nevertheless a component of a much longer international supply chain. Truck drayage systems exist at major container ports around the world, and although the trucks used at Shanghai or Rotterdam may look quite different, their function in the supply chain is very similar to drayage trucks in the United States. Although most large ports have rail linkages as well, almost all container ports rely on drayage for a large percentage of hinterland connections to surrounding urban areas.

The profile of drayage has increased sharply in the last few years as its potential role in reducing air pollution has been recognized. Ports around the country have instituted "clean trucks" programs aimed at improving the environmental performance of trucks calling at their terminals. In addition to the most well known program at the Ports of Los Angeles and Long Beach (California), programs are aimed at improving drayage emissions at Seattle/Tacoma (Washington), Oakland (California), New York/New Jersey, Houston (Texas), Baltimore (Maryland), and Savannah (Georgia), with more programs in the planning stages. These policy interventions into the dray industry make a thorough understanding of the drayage system even more important.

The impact of drayage on emissions and greenhouse gasses (GHGs) is directly attributable to time spent idling and moving. Delays that increase idling and inefficiencies that create extra trips add to emissions and congestion without increasing transportation service or value. Use of this guidebook should help participants in containerized transportation reduce such delays and keep extra trips to a minimum.

Purpose and Organization of This Guidebook

NCFRP Report 11: Truck Drayage Productivity Guide is intended to be a practitioner's guide to measuring, analyzing, and improving port intermodal drayage. The target stakeholders include port authorities, marine terminal operators, drayage firms, and regional transportation planners.

The objective of the guidebook is to give those stakeholders tools to improve drayage productivity and capacity while reducing emissions, cost, and port-area congestion.

The guidebook is organized around a logical progression of steps in an analysis of local or regional port drayage issues. Chapter 2 discusses the drayage process, and Chapter 3 covers acquisition of drayage data from a broad range of sources. Chapter 4 provides a summary matrix of drayage issues, impacts, solutions, etc. The problems and solutions listed in Chapter 4 are then discussed at length in Chapters 5 through 11. Chapter 12 describes the application of the EPA SmartWay DrayFLEET Model to drayage issues and solutions.

This guidebook is one end product of NCFRP Project 14, Truck Drayage Practices. The project was initiated at the urging of industry stakeholders concerned about shortfalls in drayage productivity and a lack of solid analytic information on how those shortfalls might be remedied. The project benefited greatly from industry participation, notably in the provision of extensive data.

Additional Port Drayage Resources

TRB. The contractor's final report for NCFRP Project 14 and its appendices are available on the accompanying CD-ROM and as an ISO image available on the TRB Web site (Go to http://trb.org/Publications/Public/PubsNCFRPProjectReports.aspx and look for NCFRP Report 11).

Ports. Local port staff are a key source of initial information regarding drayage operations in and around each port. Port operations and environmental staff usually have contact information for leading drayage firms. Some port Web sites include directories of local drayage firms. Marine container terminals operator staff can usually identify the major drayage firms serving their terminal.

Associations. There are three key organizations representing drayage firms, ports, and the intermodal industry in general.

- Intermodal Motor Carriers Conference (American Trucking Associations)—www.truckline.com
- The American Association of Port Authorities (AAPA)—www.aapa-ports.org
- The Intermodal Association of North America (IANA)—www.intermodal.org

IANA also administers the Universal Intermodal Interchange Agreement (UIIA), which specifies the terms of business for much of the port drayage industry.

Many states and port areas also have local trucking or drayage company associations, which should be accessible through port staff.

EPA DrayFLEET. The EPA SmartWay DrayFLEET Model was used for all of the emissions and cost modeling in NCFRP Project 14. DrayFLEET and accompanying documentation are available free of charge through the EPA SmartWay Web site at http://www.epa.gov/otaq/smartway/transport/partner-resources/resources-drayage.htm

CHAPTER 2

The Port Drayage Process

Port Drayage Transactions

In any port drayage operation, the need to move loaded containers drives the system. Movements of empty containers, bare chassis, and bobtail tractors ordinarily result from loaded movements. A driver's duty cycle can be a series of repetitive shuttles (e.g., between marine and off-dock rail terminals) or a complex pattern of multiple tasks.

Drivers arriving at a marine terminal entrance gate are anticipating one of the transaction types or combinations shown in Table 2–1. The shaded cells in Table 2–1 are the eight routine transactions usually found at marine terminals. They have different functional requirements that drive gate processing times and associated queuing.

Inbound or outbound bobtails (drayage tractor movements without a chassis or container) have the advantage of not needing an inspection, since no equipment is being interchanged from trucker to ocean carrier. Many terminals have separate unmanned bobtail gates for this reason. Bobtail drivers still must identify themselves and have their transaction verified (e.g., picking up an empty or loaded container on chassis). Bobtails are non-revenue moves and, therefore, are minimized.

Inbound bare chassis movements are relatively rare at wheeled terminals, and will remain so as long as the chassis fleets and pools are maintained on the terminals themselves. Bare chassis moves are much more common where space limitations have pushed chassis pools to remote lots, and where on-terminal chassis storage is limited and the overflow is drayed off site. Bare chassis moves are also sometimes required for specialized container types. Bare chassis moves will likely increase if, and when, truckers take over the chassis supply.

Inbound empty and loaded containers on chassis both need inspections. An empty container also theoretically requires the driver or clerk to open the doors to check the interior; an export load requires the cargo seal to be checked for number and condition.

Inbound loaded containers for export typically require the most paperwork, because the terminal is accepting the container and the export goods inside on behalf of the ocean carrier (steamship line).

Outbound empty containers to be loaded with exports are not inspected at the gate under the assumption that the driver has inspected the equipment (not always true) and accepted responsibility for its return in good condition (when it will be inspected by terminal personnel).

Outbound import loads outnumber inbound export loads and tend to receive most of the attention paid to drayage issues. Usually, the driver must have a "pickup number" or other means of verifying his eligibility to pick up the loaded container. On exiting the terminal, the drayage company assumes responsibility for both the equipment and the load.

Table 2–1. Entry/exit transaction types.

Transaction Types		Entry			
		Bobtail	Bare Chassis	Empty on Chassis	Load on Chassis
Exit	Bobtail	Bobtail in Bobtail Out	Chassis in Bobtail Out	Empty in Bobtail Out	Export in Bobtail Out
Exit	Bare Chassis	Bobtail in Chassis Out	Chassis in Chassis Out	Empty in Chassis Out	Export in Chassis Out
Exit	Empty on Chassis	Bobtail in Empty Out	Chassis in Empty Out	Empty in Empty Out	Export in Empty Out
Exit	Load on Chassis	Bobtail in Import Out	Chassis in Import Out	Empty in Import Out	Export in Import Out

In both inbound and outbound moves, inspection of the chassis may require more time than inspection of the container itself. This situation would change if, and when, chassis are no longer interchanged with the terminal operator or kept on the terminal.

There are many possible exceptions and variations in this process, such as:

- Dual transactions (e.g., empty return/import load, export load/import load, export load/empty pickup);
- Trouble-window transactions (e.g., documentation problems, turnaways, or the need to pick up a different container);
- Equipment issues (outbound chassis roadability, inbound damage dispute, delays for repairs);
- Off-terminal storage or repair trips (significant where refrigerated containers must be "pre-tripped" for perishable exports); and
- Dray-in imports (imports coming into the terminal that were discharged at another port) and dray-off exports (exports being re-delivered to shippers instead of being loaded onto a vessel).

All port drayage processes at terminals have the same basic objectives and the same basic steps. The following sections describe generic drayage processes for import, export, and empty moves. The complete cycle may involve more than one driver on separate days.

Marine Container Terminals

Marine container terminals all served the same basic functions but differ in ways that affect drayage operations.

"Wheeled" terminals park containers on chassis. From a drayage driver's point of view, a wheeled terminal is a self-service parking lot in which he leaves and picks up containers on chassis without interacting with terminal personnel inside the gates. For this reason, wheeled terminals are usually the easiest and most economical for drayage firms to serve. Wheeled terminals require an on-terminal chassis supply, and are rare outside the United States.

"Stacked" terminals store containers and chassis separately. Container yard lift machines, such as straddle carriers, rubber-tired gantries (RTGs), or sideloaders are used to stack containers and transfer them between stacks and chassis. To drop off a container, a driver waits at the storage area for the container to be lifted from the chassis, and then parks the chassis in a separate area (unless he reuses the chassis for an outbound move). To pick up a container, a driver must locate a suitable bare chassis (if he does not have one from a previous move) and take it to the storage area to receive the container. Serving stacked terminals typically takes longer and has more opportunity for exceptions and delays than serving a wheeled terminal.

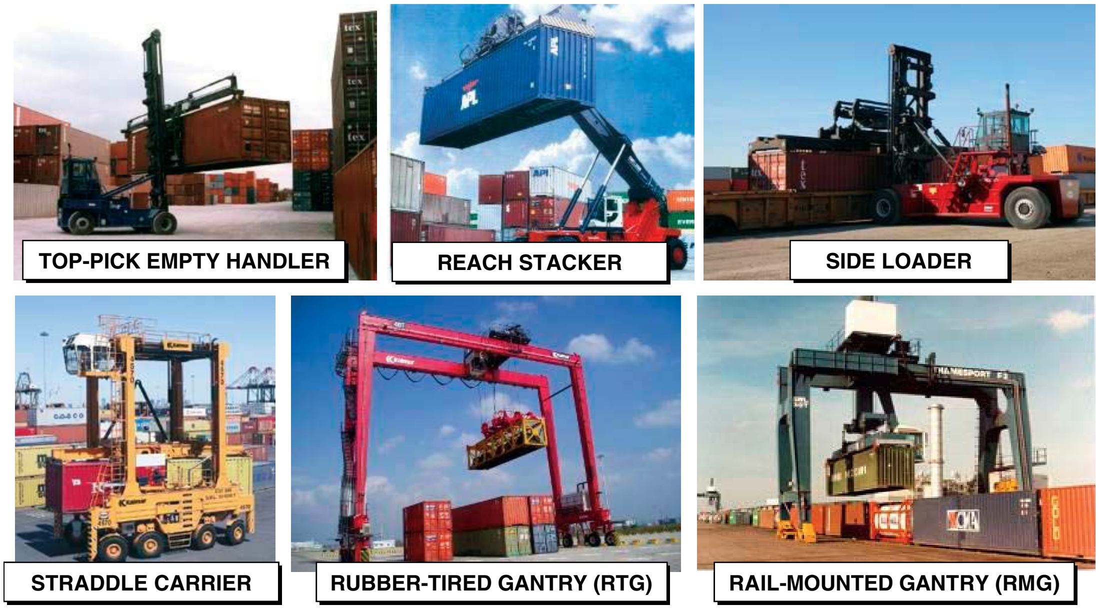


Figure 2–1. Container yard handling equipment types.

At “transfer zone” terminals, a driver dropping off a container waits in a designated area to be served by a mobile lift machine. A driver picking up a container waits in the transfer zone with a bare chassis, and the mobile lift equipment brings the container. In both cases, the driver must move the bare chassis to and from a separate area.

Almost all major U.S. container terminals are actually hybrids, with some containers wheeled on chassis, empties handled by mobile lift equipment, and loaded containers handled by RTGs or straddle carriers. Typical handling equipment types are shown in Figure 2–1. Rail-mounted gantries (RMGs) are uncommon in the United States.

Figure 2–2 displays the progression of terminal handling methods from lowest to highest density. Virtually all U.S. marine container terminals use a mix of the handling methods shown in Figure 2–1, and vary that mix to provide sufficient capacity at minimum cost. Terminal operators gravitate to low-density, low-cost operating methods whenever possible.

DENSITY	TYPE	COMMENT
VERY LOW DENSITY	Ro/Ro or Ship’s gear	Very small, barge, specialized
	Wheeled Combination	Small, mixed, legacy
	Dedicated Wheeled	Older terminals when new
LOW DENSITY	Wheeled/Top-pick	Transition terminals
	Top-pick/Wheeled	Transition terminals
MID DENSITY	Straddle/Top-pick/Wheeled	Hybrid terminal
	RTG/Top-pick/Wheeled	Dominant hybrid type
HIGH DENSITY	Straddle Carrier	NIT Virginia
	RTG	No US Example
VERY HIGH DENSITY	Pure RMG	APM Portsmouth

Figure 2–2. Progression of terminal handling methods.

Wheeled operations are the most economical for marine terminal operators because they minimize both capital and labor. Terminals prefer to put import boxes on chassis, and any specialized containers (refrigerated, tank, hazmat, overweight, etc.) as well. As wheeled terminals become crowded, the operators tend to segregate and stack empties. Empties are light and can be handled by the least expensive lift equipment, such as heavy duty fork lifts. Empties are typically stacked by type and ownership and can be managed last-in/first-out (LIFO).

As additional capacity is required (or planned from the beginning), the terminal begins stacking loaded containers off their chassis—first exports, then imports. The stacks are serviced by RTGs, straddle carriers, or—in the case of APM Portsmouth, Virginia—by rail-mounted gantries. During extended slow periods, some stacked terminals will revert to wheeled operations to reduce costs.

Uniform Intermodal Interchange & Facilities Access Agreement

The Uniform Intermodal Interchange & Facilities Access Agreement (commonly called the UIIA, based on its previous title of Uniform Intermodal Interchange Agreement) is a standard drayage industry interchange contract governing the interchange of intermodal equipment between ocean carriers, railroads, equipment leasing companies, and intermodal trucking companies. It was developed by the Intermodal Interchange Executive Committee, whose members include representatives of trucking firms, railroads, and ocean carriers, to promote intermodal productivity and operating efficiencies through the development of uniform industry processes and procedures.

The UIIA covers most aspects of equipment interchange in port drayage, including facility access, equipment interchange procedures, equipment usage rules, liability and insurance requirements, administrative processes, and dispute resolution procedures.

The UIIA is administered by the Intermodal Association of North America (IANA) and is available at http://www.uiia.org/documents/newuiia-full.pdf

Import Drayage Process

Figure 2–3 displays a generic high-level process map for the import drayage process. At the highest level, the process begins with the bill of lading and the vessel manifest—the list of import containers on the inbound ship. The manifest lists the notify parties, those parties that must be notified once the container is unloaded from the ship and ready to be picked up. For a local

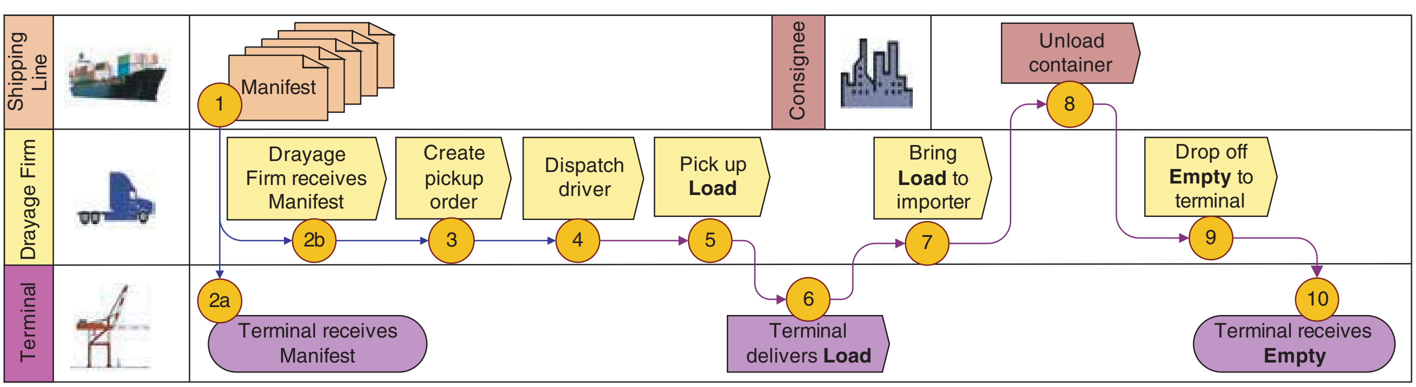


Figure 2–3. Import drayage process map.

import the "notify parties" usually include the consignee (beneficial cargo owner or an intermediate receiver such as a transloader or broker) and the drayage firm.

Once notified by the terminal operator that the container has arrived, the drayage firm will verify when the consignee wants it picked up (or, in the case of multiple containers, the preferred order of delivery). Most experienced port drayage firms will then verify that the container is indeed ready to be picked up via either the ocean carrier's online system, the terminal operator's system, or a port-wide system such as VoyagerTrack or eModal. The drayage firm will verify that the container has cleared Customs, has no unmet need for agricultural or other inspections, is not hazardous, or does not otherwise require special handling, and that all fees have been paid.

Correct pre-trip usage of such systems is a major factor in reducing exceptions and delays at the terminals. Consistent and correct usage of the various information systems is also a distinguishing characteristic of experienced port drayage firms.

With the availability of the import container verified, the drayage firm creates a pick-up order and dispatches a driver to the marine terminal. Depending on the previous dispatch, the driver may have no box or chassis (bobtail), an empty container on chassis, an export load, or a bare chassis. Drayage firms attempt to maximize revenue moves by avoiding non-revenue bobtail or bare chassis moves and using every opportunity to return empty containers without making extra trips.

At the terminal, the driver will go through the gate and container yard subprocesses, detailed in the following guidebook sections. These subprocesses vary between ports and terminals, but all have a few common objectives, as follows:

- Verifying the identity of the drayage driver and drayage firm,
- Verifying that the driver's transaction is legitimate and that the desired container is available and cleared for pickup,
- Checking the condition of any inbound equipment and issuing an Equipment Interchange Report (EIR),
- Performing the exchange of container and chassis within the container yard, and
- Verifying the transaction and completing an EIR for outbound equipment.

The EIR serves a critical function since it documents the transfer of responsibility for the equipment and its contents between parties. When a driver takes a loaded container or chassis out of the terminal, the drayage firm assumes liability for its timely return in good condition. If the equipment is returned after a specified "free time," the drayage firm will be charged ("demurrage") for the excess time. If the equipment is judged to have been damaged (beyond normal wear and tear), the drayage firm will be charged for repairs. When equipment is returned to the terminal and inspected, the terminal operator is accepting responsibility and releasing the drayage firm. Under normal circumstances the importer or exporter does not ever take responsibility for the container or chassis.

Having obtained the loaded import container on a suitable chassis, the driver will then deliver it to the consignee (or alternatively, to a rail intermodal terminal or even another marine terminal for ongoing movement). At the consignee location, there are the following two basic options:

- "Drop and pick," in which the driver positions the import container for subsequent unloading and retrieves a previously emptied container for return to the port, and
- "Stay with," in which the driver waits while the container is unloaded and then returns it to the port.

"Drop and pick" operations are preferred because they make better use of the driver's time. "Stay with" trips are usually limited to low-volume customers where there may not be an empty to exchange, or to long-distance customers where the wait for unloading is short compared to the driving time.

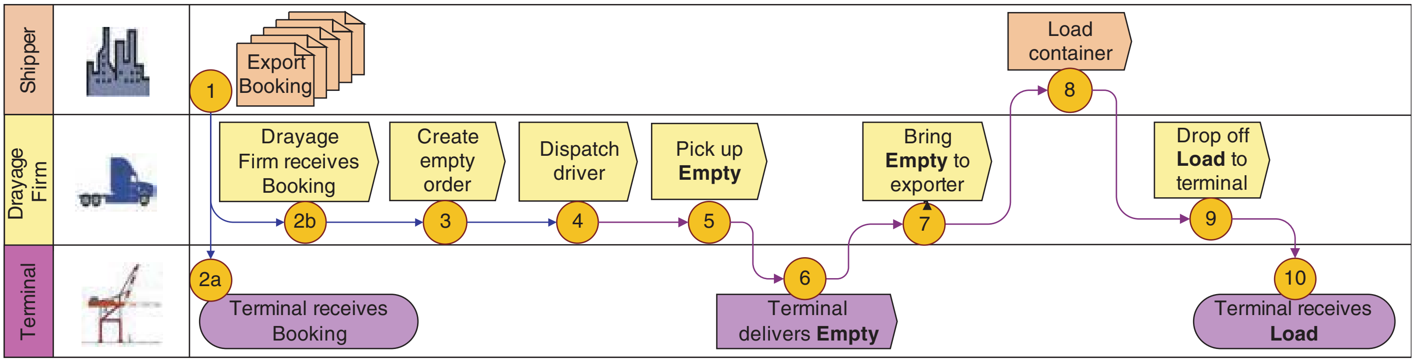


Figure 2–4. Generic high-level export drayage process.

The empty container is then returned to the marine terminal where the driver goes through the same basic gate and container yard subprocesses.

Export Drayage Process

Figure 2–4 displays a high-level map of the export drayage process. It differs from the import drayage process in a few basic ways.

The cycle starts with an export booking by the shipper, essentially a reservation for an outbound container on a specific voyage. The booking is assigned a "booking number" and transmitted to the drayage firm and the marine terminal. The marine terminal creates an Equipment Delivery Order (EDO) or equivalent, giving the drayage firm permission to pick up an empty container for the export load.

- The drayage firm should receive or confirm the empty order via the on-line systems as explained above. Doing so will reduce the chance of exception or delay at the marine terminal.
- A driver is dispatched to the terminal and goes through the applicable gate and container yard processes to obtain the empty container.
- The empty container is drayed to the shipper's location. The driver either exchanges it for a load (drop and pick) or waits while it is loaded (stay with).
- The loaded export container is then drayed to the marine terminal. The export booking number is the key transaction identifier at the gate.

Ordinarily, the export container or chassis is inspected and accepted, and an EIR issued. In the absence of any exceptions, the driver will be given instructions on where to take the container within the terminal. Finally, the driver will leave the load and either start another transaction or leave.

Empty Return Process

After the goods are unloaded from an import container, the empty container must either be returned to the marine terminal, dropped at an off-terminal depot, or reused for an export load.

Return to Terminal

Most often, the empty container is returned to the marine terminal. At the inbound gate, the driver will identify himself, his firm, and the transaction. The empty container and the chassis will be inspected either in person or via video camera. The driver may be asked to open the doors to verify that the container is clean and empty. If the container and chassis pass inspection, an EIR will be issued for the return, and the driver will be given instructions on where to take the equipment.

Return to Depot

Empty containers may be stored in off-terminal depots because they are being "off-hired" (returned to a leasing company) or because a scarcity of space forces them out of the main terminal.

Reuse

Reusing an empty import container for an export load, sometimes called a "street turn," can significantly reduce drayage trips. There are, however, major institutional and informational barriers to reuse, and the practice is uncommon at most ports.

Drayage Subprocesses

Within the overall drayage process there are several subprocesses that reoccur. These are discussed below to emphasize the commonalities.

Security

Since September 2001, Customs and Border Protection (CBP) has adopted the goal of passing every import container through a radiation portal monitor (RPM) at the marine terminal. As of 2008, implementation of this process still varies widely, with many major terminals having RPMs on site, but others having RPMs outside the terminal or shared by multiple terminals.

The TSA-issued Transportation Worker Identification Credential (TWIC) is gradually being implemented at U.S. ports. A TWIC is required for any drayage driver entering the terminal. TWICs have embedded RFID capability, but the RFID readers are not yet available. Marine terminal entry gates are thus having drivers display TWICs for visual inspection. Eventually, TSA plans to incorporate TWIC readers in entry gate installations.

Some ports and terminals have additional security requirements or procedures. One example is the Port Check identification card issued at the Port of New York and New Jersey.

In-Gate Processing

At the marine terminal, the driver will join the queue (if there is one) at the inbound gate as shown in Figure 2–5.

The inbound gate process fulfills multiple purposes, as follows:

- To verify the identity of the driver and his firm, and their eligibility to complete the transaction (e.g., picking up an import load);
- To verify that the specified container is indeed available and ready to go (cleared, with all fees paid);
- To check the condition and complete an EIR for any ocean carrier equipment being interchanged (container, chassis, genset);
- To instruct the driver where to pick up the container; and
- To dispatch or queue-up the required terminal lift equipment.

Although there are many minor variations on inbound gate configurations and processing, there are two basic types: one-stage and two-stage.

Source: Port of Los Angeles Web site.

Figure 2–5. Marine terminal entrance gate.

One-Stage Inbound Gates

At a one-stage gate, all of the above functions are typically fulfilled by a gate clerk in a booth. The driver usually does not communicate with terminal personnel until reaching the actual gate. All gate processes are performed there, including any problem resolution. The clerk will accept information from the driver, enter it in the terminal information system, verify the transaction, inspect the equipment, and issue a written "yard slip" or oral instructions on where to proceed in the container yard.

If exceptions occur at a one-stage inbound gate, the clerk usually tries to resolve them on the spot. This delays not only the affected driver, but also all the other drivers queued up behind him. For more complex problems the driver may be sent to a separate "trouble window." Instances in which the driver cannot enter the terminal (e.g., no valid interchange agreement or no legitimate transaction) are particularly troublesome, as such "turnaways," and seriously disrupt the flow of traffic through the gates.

One-stage gates are most often found at older or smaller terminals where the volume of business may not justify the investment in two-stage systems or where there is not enough physical space.

Two-Stage Inbound Gates

Two-stage gates (Figure 2–6) have become the norm for newer and larger marine terminals. There are many variations, but the two stages are usually divided as follows.

In the first stage, the driver pulls up to a pedestal equipped with a phone, keypad, card reader, or other device for communicating with the terminal clerks and information system. This first stage establishes the identity of driver and drayage firm, verifies the legitimacy of the transaction, and verifies container availability. If an exception occurs in any of those steps and cannot be resolved within a couple of minutes, the driver is either turned away or sent to a trouble window. The first stage pedestals should be located far enough from the second stage gates to allow trucks to leave the queue with a minimum of disruption. Exceptions at this stage should cause only a short delay to other trucks in the queue.

Once the "paperwork" is done (mostly electronically), the driver is advanced to the second stage, which is the actual terminal entry gate. At this point, any inbound equipment is inspected, whether in person or remotely via video cameras, and a yard slip with instructions is issued. Exceptions at the second stage would most likely involve equipment condition, and such units would be sent to a trouble window.

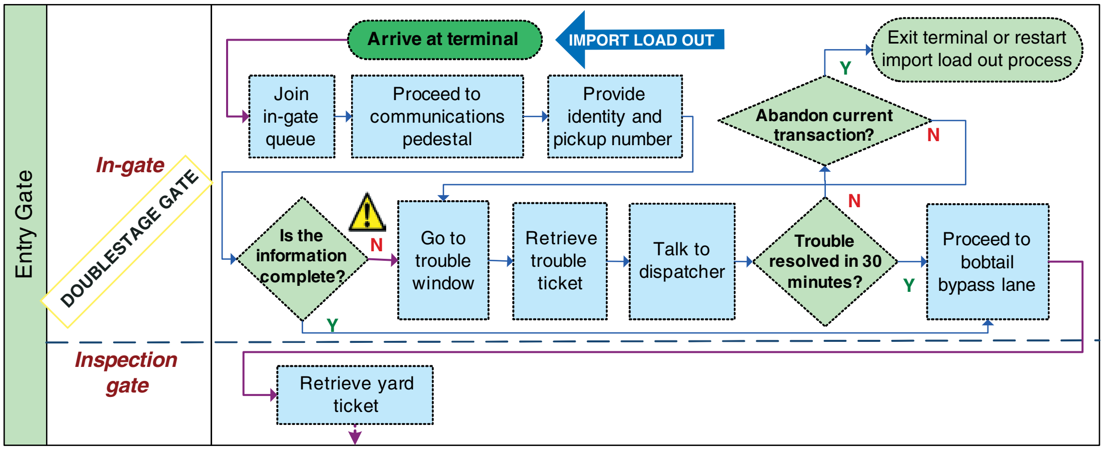


Figure 2–6. Two-stage in-gate subprocess.

Two-stage gates have the advantage of identifying and segregating (or turning away) drivers with transaction problems before they reach the actual terminal entry. When combined with video inspection systems they also allow terminal operators to physically distance clerks from the gate itself and from personal interactions with drivers (which can sometimes become contentious).

Two-Stage Gate Equivalents

Some terminals are experimenting with other gate configurations. At Bayport in Houston, the one-stage gate will still have the ability to remove problematic trucks from the gate processing area and thereby prevent them from creating a bottleneck. Staff determined that processing at each stage was fast enough that there was not a sufficient need to have the trucks stop twice.

On-Terminal Chassis Supply

Once in the container yard, there are the following three principal ways for a drayage driver to locate and hook up to a container or chassis:

- By locating a container already mounted on a chassis at a wheeled terminal,
- By locating a bare chassis and taking it to a container stack where a lift machine will mount the container in a stacked terminal, or
- By locating a bare chassis and taking it to a designated zone where a lift machine will bring and mount the container in a transfer zone terminal.

In all three cases, the driver goes through the process of locating, inspecting, hooking up, and testing a chassis. Figure 2–7 displays this process.

Data obtained from two case study terminals illustrate the extra time required for obtaining a chassis at the terminal. At one terminal, grounded transactions that required the driver to obtain a terminal chassis averaged 16 minutes longer than grounded transactions for which the driver brought a chassis. At the other, less congested terminal, the average difference was 9 minutes. The weighted average was 12 minutes longer when a chassis search was required. In both cases, the standard deviation was smaller when the trucker provided the chassis, indicating less variability. These differences probably reflect two factors: the additional gate time required to interchange and inspect the chassis, and the time required within the terminal to locate and check an appropriate chassis.

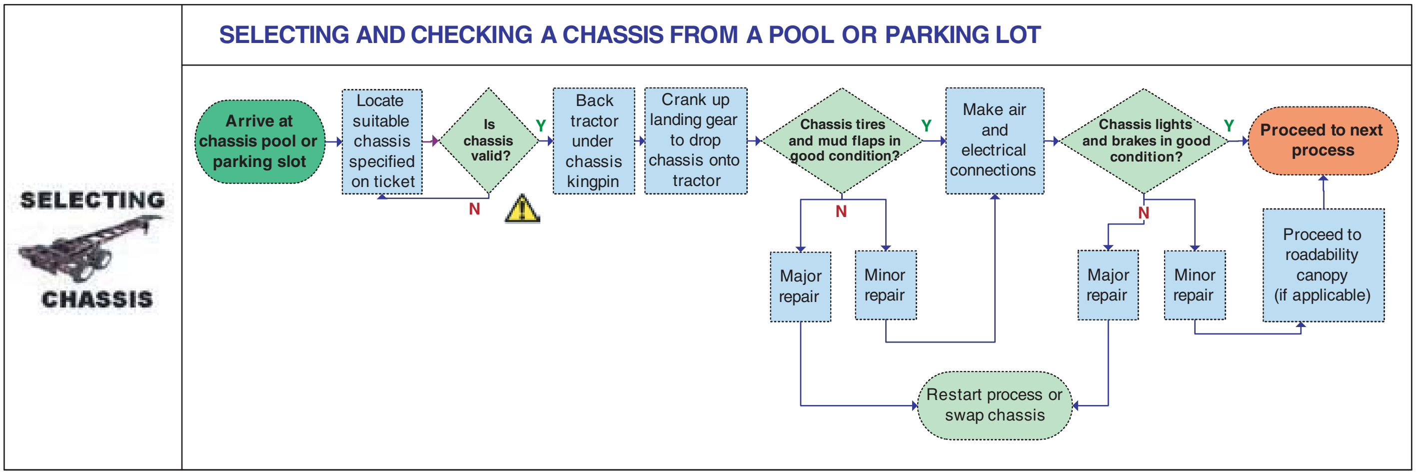


Figure 2–7. Chassis subprocesses.

Radiation Portal Monitor Processing

Radiation portal monitors (RPMs) are installed and operated by CBP or contractor personnel. RPMs (Figure 2–8) are designed to detect any unusual radiation from a container, indicating the presence of potentially dangerous undeclared cargo (contraband or a weapon). Any radiation detected by the RPM is compared with the known characteristics of the declared cargo. If the radiation pattern is consistent with the cargo, the container is released. If not, the container may be rescanned at the RPM, sent for more intensive Vehicle and Cargo Inspection System (VACIS) screening, held for CBP inspection, or sent to an off-terminal inspection station.

Source: SAIC Web site.

Figure 2–8. Radiation portal monitor.

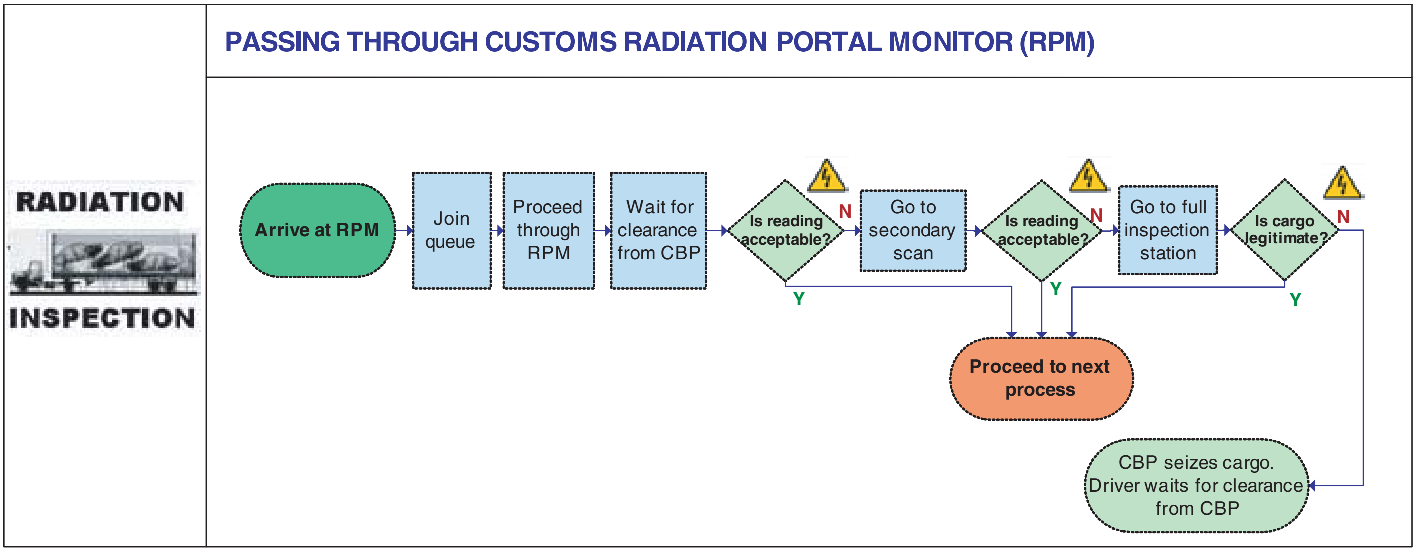


Figure 2–9. RPM subprocesses.

As Figure 2–9 indicates, routine processing through an RPM involves waiting in a queue, passing through the RPM, and waiting for CBP clearance. The process takes only a few minutes unless there is a long queue.

RPM placement is not yet completely standardized and can vary by port and terminal. CBP's preference is to have all RPM screening within the terminal, before the driver reaches the exit gate. In some current installations such as Maher Terminal at NYNJ, however, space constraints have led to placement of the RPMs outside the terminal inspection gates as a separate security process step. Delays and exceptions can occur in RPM processing when

- Long queues develop because of peaking or a shortage of operable RPMs (due to down time or staffing shortfalls);
- False positives occur, leading to rescans; or
- Radiation readings are inconsistent with declared cargo (often due to inaccuracy or misdeclaration), and lead to a CBP "hold" until resolved.

The first two instances may impose delays of up to around 30 minutes. A CBP "hold" stops the transaction, forcing the driver to either leave or switch to another assignment.

Out-Gate Processing

Processes at terminal exit gates or out-gates are ordinarily simpler and quicker than at inbound gates. The primary purpose of out-gate processing is to verify that the driver has completed the correct transaction and that any necessary paperwork or systems entry is complete.

- Drivers leaving bobtail, without chassis or equipment, often exit via a bypass gate.
- Drivers leaving with containers on chassis will present or enter yard slips or pickup numbers to verify that they have a legitimate transaction and have picked up the correct unit.
- There are ordinarily no inspections at the outbound gate. For outbound empties or loads, an EIR is completed and issued under the assumption that the driver has completed any necessary inspections and repairs, and that the equipment is in good condition (and that any damage found at a subsequent inbound inspection is the responsibility of the drayage firm). Any exceptions or disputes relating to equipment condition would ordinarily be resolved before the driver reaches the outbound gate.

CHAPTER 3

Drayage Data and Information Sources

Data and Information Needs

Drayage data are required for the following three basic purposes:

- To measure and analyze drayage bottlenecks and delays,
- To evaluate potential solutions and best practices, and
- To calibrate DrayFLEET or other cost and emissions models.

Bottlenecks extend the overall cycle time (e.g., terminal to customer and return) beyond what is necessary to accomplish the actual work of transporting the container. Bottlenecks will thus be manifest as larger-than-necessary cycle times. Identifying and measuring bottlenecks will require data on the overall cycle time, its components, and—especially—those components that contain potential bottlenecks.

"Before-and-after" time series data or "with-and-without" cross-section data are needed to evaluate potential solutions and best practices. Terminal operators often make process or facility improvements to avert the development of significant problems rather than waiting for the problems to develop. The "improvement," therefore, is sometimes only evident in comparing the present performance with a hypothetically worse performance.

Although discussions with drayage firms and terminal operators can suggest likely bottlenecks and sources of delay, more intensive data mining is usually necessary to verify, quantify, analyze, and prioritize the issues.

DrayFLEET and other emissions or cost models require data on port characteristics, cargo flows, distances, cost factors, etc.

Depending on the issue to be analyzed, data may be needed on the whole drayage cycle, as follows:

1. Travel times to marine terminals,
2. Inbound gate queue times,
3. Inbound gate processing times,
4. Container yard transaction times,
5. Outbound gate queue times,
6. Outbound gate processing times,
7. Travel times to customers (or depots or rail terminals), and
8. Transaction times at customer locations (or depots or rail terminals).

Each of these eight generic time segments may need to be investigated in depth and broken down into such levels of detail as are appropriate, supportable, and informative. There are several potential sources for these data as follows:

- Marine terminal operating systems,
- Webcam terminal data,
- Drayage companies,
- State or local departments of transportation,
- Surveys, and
- Special studies.

Data alone do not tell the whole story. As noted, discussions with drayage firms and terminal operators also can suggest bottlenecks and sources of delay. Once bottlenecks have been identified and delays quantified through data analysis, the insights of drayage firms and terminal operators are crucial in discerning cause-and-effect relationships and potential solutions. Drayage firms often are aware of best practices at other terminals or ports, and are in a position to compare operations and outcomes. In NCFRP Project 14, the study team benefited greatly from contacts with terminals and drayage firms, site visits, and opportunities to observe daily operations.

Understanding the priorities of drayage drivers is particularly important when assessing the potential effectiveness of policies aimed at improving dray efficiency, such as extended gate hours. Also, drivers are motivated differently depending on their compensation method. Drivers who are paid per load have a different motivation than drivers who are paid by the hour.

Marine Terminal Information Systems

Every marine container terminal utilizes a terminal operating system (TOS) to help it manage and keep track of the flow of containers through its gate, yard, and berth. In the past, many terminals relied on their own in-house software and tools. In today's fast-changing environment with rapid technological advances and constant practice changes, terminals are finding it more cost effective, convenient, and reliable to outsource this service to third parties. In addition to providing the core functionalities for terminal operations, the TOS is often linked to other systems such as billing, gate automation technology, and Web-based applications where customers can track their containers, make payments, and/or make an appointment.

Because of the need to provide customers with up-to-date information on a container, a great deal of information is tracked for every container. Regarding drayage operations, in the normal course of operations the marine terminal operators and their information systems record data on the following:

- Volume—Daily gate transaction volumes (and therefore weekly, monthly, and annual values) by transaction type and time of day as well as shipping line, trucking company, container number, and characteristics Most terminals also keep track of the number of double moves that are made at their terminals.
- Gate processing—In-gate processing times, implicitly defined as the time between first contact (often at a first-stage pedestal) and the issuance of a yard slip or other directions to leave the gate and enter the container yard. Note that this time span could include a significant wait between the first contact point and the actual gate in a two-stage system. This time does not include the trucks' queuing time while waiting to gain access to the first-stage pedestal.
- Out-gate exit times—The terminal system may or may not capture the time at which a driver starts the out-gate transaction, but will definitely live-stamp the issuance of an EIR or other document completing the interchange process.
- Turn times—A key performance measure associated with drayage operations is truck turn time. This is the difference between the truck's exit time and the truck's entered time.
- Trouble tickets—Trouble tickets are a key factor in terminal delays, and are discussed in more detail below.

In theory, then, marine terminal operators should be able to provide complete, accurate information on gate flows and transactions from their information systems. In practice, the accuracy and accessibility of gate information will vary with the accuracy of inputs, the rigor with which the system is maintained, and the experience of those accessing the data.

The operations manager and gate supervisors typically review the turn time report daily. Although the format of this report varies from terminal to terminal, it will include the turn times by transaction types (e.g., import, export), container types (e.g., dry van, reefer, flat rack), and the overall average, median, minimum, and maximum turn times. Some terminals will also include turn times of trouble transactions. To help the managers and supervisors understand how turn times were affected by the work load, the turn time report may also include the number of gate moves, warehouse moves, rail moves, the number of available equipment, and the number of trouble transactions.

In requesting data from the terminal operators, researchers should be mindful of several challenges and pitfalls, including the following:

- Some terminal data may not be as easy to access and compile as the request may anticipate. To obtain the data, the terminal operator may have to create a special database query, which requires time and effort.
- There may be gaps in the data.
- Every container terminal is set up differently.

Thus, analysis of performance measures such as turn time should consider the characteristics of that terminal. For example, some terminals have the RPMs inside their gates and others have them outside. Obviously, the truck turn times will be higher for those terminals with the RPMs inside their gates.

There are very few common marine terminal operating systems in use, and each has its strengths and weaknesses in drayage transactions. The weaknesses tend to be addressed over time, but the feedback loop from frustrated drayage driver to terminal software engineer can be a long one.

Terminal data files can be very large, with some annual compilations exceeding 1 million records. Also, terminal data are proprietary, and any data request must be accompanied by appropriate safeguards for confidentiality.

Gate Processing and Turn Time Data

Container terminal operating systems collect information on gate activity. The gate data are entered by the clerks who check inbound and outbound trucks, or through automated systems such as swipe cards or optical character recognition (OCR) camera systems. When a drayage driver pulls a container from the terminal interchange, documents are completed to transfer legal custody of the container and chassis (and the contents, if loaded). Movement of loaded containers, empty containers, and bare chassis to and from the marine terminals thus tends to be well documented, but some reconciliation between interchange documentation and gate records may be required. Bobtail trips have not been documented as carefully in the past, but should be more accurately recorded with increased security concerns.

A marine terminal information system will typically assign a unique record number to each transaction. A transaction is defined as an instance where the terminal staff interact with a truck, either in the gate or in the yard. The most reliable data are captured at the in-gate and the out-gate. Sometimes records are generated within the terminal, such as a record of when the truck was loaded by a gantry crane. One challenge in analyzing terminal records is aligning transaction records with truck visits. For example, a truck may generate several transaction records in the course of a single visit in which it drops off one container and picks up another. Some data manipulation can be required to get the terminal database to "tell the story" of each individual truck trip.

Trouble Ticket Records

Trouble tickets are created by the marine terminal when a drayage driver's planned transaction cannot be completed without special human intervention and resolution. Trouble tickets result most often from documentation or process issues, but occasionally are due to container location or equipment issues. Marine terminals typically keep historical records and monitor the reasons for trouble tickets. Some trouble tickets may result in a minor administrative delay whereas others may result in a longer delay or the abandonment of the transaction. On average, each trouble ticket adds about an hour to the turn time as well as requiring additional administrative time for the marine terminal and other operating personnel, depending upon the particular circumstances. The study team found that approximately 5% of all such transactions result in trouble tickets, and this rate was relatively consistent across the participating marine terminals.

The analysis of trouble ticket data can be used to provide information and insight necessary to evaluate the overall effectiveness of communications and administrative processes in the logistics chain. At this level, the results cannot be used to blame or find fault with any individual party or group. The trouble ticket "reason" codes simply report the symptom and not the cause of the trouble. For example, in this kind of system a trouble ticket labeled as "dispatch error" may the fault of the motor carrier dispatcher or the party that provided the dispatcher with bad information.

To perform this kind of analysis the researcher will need to

1. Obtain the raw data from the marine terminal. Typically, these data can be provided interactively or in an electronic format such as Excel or Access.
2. Analyze the data to produce a frequency distribution to determine if particular "reason" codes are more/much more important than others.
3. After reviewing the data, consult with the marine terminal to ensure that the codes are well defined and well understood, and determine when and where the codes are applied and by whom. Codes have been created to serve the marine terminal and are in the local jargon. At the end of the interview the researcher should thoroughly understand the definition of all the data elements as well as the reliability of the process used to create the data. A potential problem with trouble ticket data is that several different workers are typically applying the codes. Because there are many different workers and many codes with similar definitions, it is likely that codes are somewhat inconsistently applied.
4. As necessary, categorize and summarize data to provide meaningful information and to mitigate the inconsistencies inherent in the data collection process.
5. If possible, correlate trouble ticket data with driver experience level, motor carrier, customer, marine terminal, transaction type, or marine carrier. Although this kind of analysis can begin to focus attention on problem areas, they are not, in and of themselves, sufficient to fix blame. To actually determine the fault, a thorough investigation would be required for each trouble ticket.
6. Provide the information and associated implications to the marine terminal. The results may be useful to the firm for management purposes, and review by the marine terminal provides a necessary reasonableness check on the research results.

Trouble ticket data are most useful in determining which types of process exceptions are most common and where follow-up analysis would be most useful. For example, the NCFRP Project 14 study team found that most trouble tickets were generated by process, information, and dispatch issues, rather than for equipment or security problems.

Drayage Company Data

Company Records

Drayage companies keep records of the trucks that make up their fleet (trucks leased from owner-operators). Drayage companies also may have dispatch logs showing which trucks were dispatched and for which containers they were dispatched. Drayage companies also keep safety inspection records. Individual owner-operators keep records of their repairs and maintenance.

Company data can be used to understand the various marine drayage tasks a driver is assigned to perform. A motor carrier typically bills for its services based on a driver's report of work performed. These records document the activities of a driver, showing what work was done, how it was done, for what customer, and the time it required. In addition, motor carriers have dispatch logs showing which trucks were dispatched and for which containers they were dispatched. These companies also keep safety records. Individual owner-operators keep records of their repairs and maintenance.

Although some motor carriers may maintain this information in a useful electronic format, actual recordkeeping varies widely and is tailored to suit the needs of the drayage firm, not the researcher. As a result, a large number of driver time records must often be manually examined and data recorded on an Excel spreadsheet. Then this information can be analyzed to estimate turn times for different marine terminals for different types of turns (i.e., double loaded move or bobtail in/load out).

The main problem with this type of data is that it is commercially very sensitive and not often available to the outside researcher. In addition, individual driver records have the problem associated with any manual contemporaneous record; the quality and reliability depend on the level of diligence of the individual driver.

GPS/AVL Data

GPS/AVL Capabilities

A growing number of drayage firms utilize global positioning systems (GPS) or automatic vehicle locators (AVL) to track and dispatch their vehicles. GPS/AVL records are sometimes required as a reporting requirement for trucks that participate in air quality grant programs. In other cases, GPS or RFID is used to ensure that drayage trucks do not enter city streets or other corridors that are not prepared to accommodate commercial loads. AVL systems also are used for theft recovery, and some insurers give discounts to drayage firms that use such systems. "Fleet telematics" systems take the concept further by permitting two-way data exchange between the vehicle and the home terminal.

Such systems provide an unprecedented opportunity to obtain highly detailed objective data on drayage movements. For example, these systems are capable of automatically recording the following:

- Terminal arrival,
- Idling in the terminal,
- Terminal departure,
- Average speed in the terminal area, and
- Driving times and speeds between terminals and customer locations.

Most critically, these systems are the only means of automatically collecting data on terminal queue times.

There are a number of commercial providers of such systems, including the following:

- Qualcomm—www.qualcomm.com/products_services
- Teletrac—www.teletrac.net
- FleetMatics—www.fleetmatics.com
- Advanced Tracking Technologies, Inc.—www.advantrack.com

Although there have been special programs to equip drayage tractors with GPS systems specifically to collect data, utilization of commercial systems already installed by the drayage firm or driver offers multiple advantages, including lower cost.

The data are limited in that there is no automatic linkage to confirm what the truck was doing in the marine terminal. As such, the data produce accurate turn times, which may not be matched to the type of turn (i.e., double loaded move or bobtail in/load out) without additional manual effort.

GPS Data Acquisition Example

A motor carrier that regularly serves the Port of New York and New Jersey made Qualcomm/GPS data available to the NCFRP Project 14 study team. The team used the information to measure the time spent at a marine terminal, both inside the gate and in the queuing area.

The first step in the process was to become familiar with the current operating patterns of the motor carrier. A day was spent with the dispatcher and a month of driver time sheets were reviewed and analyzed. The drivers recorded the time they spent at the marine terminals and these data were used as a reasonableness test for the subsequent GPS analysis. This step is essential to ensure validity and accuracy.

Next, using the motor carrier's system, the research team established geofenced areas corresponding to the marine terminals and the auxiliary container and chassis yards serving those facilities (Figure 3–1). Qualcomm allows a boundary to be created around any particular geographical feature such as a marine terminal, container yard, customer location, home terminal, etc. The process uses satellite photos and is very similar to that used in Google Earth to establish boundaries. The system matches the polled positions with the geofenced areas and produces a report of history of positions for each vehicle.

Source: The Tioga Group, Inc./Qualcomm/Google Earth.

Figure 3–1. Geofenced area for Global Marine Terminal, NY-NJ.

The third step in the process was to take test data from the Qualcomm system. This was successful as a proof of concept, but the polling frequency was too long to produce reliable results.

The next step was to modify the Qualcomm system to poll the location of the truck fleet every 5 minutes for 4 weeks during January 2010. These individual reports were converted to Excel files, combined, and then analyzed to produce the resulting performance measures. As part of NCFRP Project 14, the Tioga Group analyzed the information for nine trucks from January 1 to January 26 as a pilot. The raw data produced by Qualcomm is simply a list in Excel of every observation. Qualcomm investigated, but did not have a regular turn time report in their standard package. As a result, these lists were reviewed manually to identify the time a truck entered one of the geofenced areas and the time it left. Once the month was complete, the full data set had 1,888 usable marine terminal cycles. These were used to produce various turn time frequency distributions, as well as to provide standard statistics such as mean and mode.

The biggest issue with the data was false positives and false negatives. These occur repeatedly because the terminals, regularly used roadways, and the motor carrier's domicile are in very close proximity. During the manual analysis of the raw data, single, isolated positives or negatives were ignored. Therefore, if a truck was in one marine terminal for 20 minutes, listed in the adjacent terminal or outside the terminal for one reading, and then back in the terminal for the next reading, the truck was assumed to be located in the marine terminal for the entire time. Also if a truck was on a dispatch that went past a marine terminal and showed in the terminal for one reading, that observation was also ignored.

Remote chassis and container facilities were separately geofenced. Where it was obvious that a truck was dispatched to pick up a chassis and then immediately pick up a load at the main terminal, these cycles were combined to produce a cycle time that reflected the full service provided. The same is true for the case in which a chassis yard cycle immediately followed a main marine terminal cycle.

Local and Regional Traffic Data

DOTs collect a limited amount of information that may be useful in analyzing dray operations. The records collected by DOTs are used for broad planning purposes and, for this reason, usually are not designed to discern the subtle distinctions that characterize dray operations. Rather, DOT records should be seen as providing context as to the overall level of congestion, from all vehicle types, on corridors that could be impacted by drayage.

Typically, each DOT has a network of permanent sites that are regularly used to collect data in an on-going fashion. The data collected are usually annual average daily traffic (AADT) in which trucks are not discerned from passenger vehicles. On a sample of highways, classification counts are made to develop factors that can translate average vehicle counts into autos and trucks. This can be viewed as a calibration exercise to obtain estimates of truck flows. Sites may be located on key ramps or highway segments that serve marine terminals (e.g., California) but, in general, state DOTs leave data collection responsibilities to metropolitan planning organizations (MPOs).

For roadways in close proximity to a port terminal, there are cases where almost all traffic is made up of dray vehicles and, in this sense, the total traffic count would approximate the dray impact. For the majority of roadways, however, dray traffic will constitute a small share of total traffic. Therefore, the magnitude of the impact of drayage can be assessed by comparing truck generation from the terminals with total traffic counts on connecting corridors and removing the share of dray trips that terminate in close proximity to the terminal itself and therefore do not significantly interfere with passenger vehicle movements. Dray truck volumes on networks are best derived from origin/destination (O/D) samples at the terminal gates with a small number of calibration sites at key highway locations near the port, such as ramps.

Surveys

Driver and Drayage Company Surveys

There are no regularly maintained public databases related to drayage activity or operations. The industry is not subject to economic regulation, and has no operational reporting requirements. Safety, licensing, and insurance information may be available but is not relevant to the objectives of this project. As a result, existing drayage data reside almost exclusively in studies, with data collected for the purpose mostly through surveys of drivers and drayage firms.

Surveys of drayage firms and drivers can be reliable and useful for three purposes.

1. To document and quantify factors that are not recorded in operating systems or other data collection routines. Examples could include the frequency with which importers insist on specific containers (regardless of how long it takes the driver) and the frequency with which drivers whose export loads have been turned away from terminals chose to wait for resolution rather than parking the load.
2. To obtain the perceptions of managers, dispatchers, and drivers regarding bottlenecks and other issues being studied. Although quantifying and documenting these issues is a primary study objective, a gulf between perception and quantified reality may signal a critical measurement or definitional issue.
3. To ensure that the study has not missed significant issues or factors. One useful practice is to always include an open-ended survey question to ensure that respondents can convey other issues of concern.

Surveys that ask for quantified estimates of average turn times, gate queue times, or trouble ticket frequency are likely to be met with off-the-cuff guesses. Drivers do not ordinarily have data on turn times, and trucking company executives or dispatchers would have to compile any available data to obtain averages or distributions. Inconsistencies are, unfortunately, common in survey data. Survey responses are not constrained by mathematical rules, and tend to reflect recent experience or on-going complaints rather than actual averages. For this reason, researchers need to be very careful about how surveys are constructed and how their results are used.

The research team found that surveys or interviews of drayage company managers and dispatchers were more cost-effective—and just as valuable—as driver surveys. Moreover, company personnel have a broader perspective than do drivers and have access to company records, whereas drivers must rely on memory and impressions.

One of the most practical and useful set of opinion surveys designed to measure the satisfaction level of motor carriers with the performance of marine terminals was initiated by the bi-state harbor carriers in New Jersey more than a decade ago. Marine, rail, and container yard (CY) terminals are graded monthly by port motor carriers on several service dimensions using A–F "school–type" grades. The methodology had the advantage of being easy, relatively consistent, and sustainable over the long term. The results provide a regular basis for discussion and improvement throughout the port community. During the course of NCFRP Project 14, the results of these surveys clearly showed their utility. The system identified a terminal that was having severe operating problems. The terminal's grades showed both the degree (D and F grades) and duration (several months) of those problems. The motor carriers used the results to enlist the support of others in the port community to pursue resolution of the problems.

NCFRP Project 14 Survey Example

As a part of this effort, the research team surveyed port drayage drivers and drayage company personnel (managers, dispatchers) seeking information relevant to the study. A draft survey instrument was used in a small number of pilot interviews. The survey instruments were refined and finalized. The survey followed conventional methodology.

- The research team identified candidate drayage companies from port workshops, referrals, and personal knowledge. The survey was distributed through the drayage companies, who responded to the company surveys and distributed the driver survey to their drivers. This methodology produced a selection bias toward relatively more conscientious and responsible drivers and firms.
- In the NY/NJ area, the research team contacted the Association of Bi-State Motor Carriers and attended their meetings to request cooperation.
- Members of the research team contacted LoadMatch.com, a service that assists intermodal truckers (chiefly those who serve rail terminals) to locate matching loads and avoid empty moves. An online Survey Gizmo version of the company survey was created and LoadMatch distributed the link to its subscribers.

The results were interesting but inconsistent and of limited value. The most valuable use of the survey was in verifying that the team had indeed addressed the most critical issues. There are a number of problems/limitations associated with motor carrier and driver surveys that were encountered in the project survey. The team received significant resistance from the port community, particularly in Los Angeles/Long Beach and Northern New Jersey, for a number of reasons, as follows:

- Many of the drivers have been surveyed several times. Change has come slowly to the industry, so response rates are low and results can be unreliable.
- There was some resistance on the part of drivers/companies to contribute their productive hours toward intangible results.
- The result of these surveys is opinion data, which is less highly regarded and useful than objective data.

The team concluded that the opinion survey efforts were the least rewarding of any of the data gathering methods used in this analysis, and that further use of driver/company surveys should be very limited and carefully focused toward specific realistic objectives. Alternate, more precise, methods are increasingly available for determining information available only by opinion survey for most of the past decade. Survey instruments are reproduced in the following sections.

NCFRP Project 14 Port Drayage Driver Survey Form

The survey form given to drayage drivers is reproduced here (response spaces have been deleted).

Please complete the following survey and turn it in to your dispatcher. Your name and answers will be combined with the responses from all the other drivers and kept confidential.

Turn Times at Marine Terminals

1. In your experience, what are the major causes of congestion at marine container terminals?
2. In the spaces below, please enter **the amount of time in minutes you would allow** for each type of move with no congestion, with routine congestion, and with peak congestion.

Expected turn time* in minutes for . . .	Terminal Condition		
	No Congestion	Routine Congestion	Peak Congestion
Bobtail in/Load out			
Bobtail in/Empty out			
Load in/Bobtail out			
Load in/Empty out			
Load in/Load out			
Empty in/Bobtail out			
Empty in/Load out			
Empty in/Empty out			

*including time in line and time in the terminal

If these times are different at each terminal, please explain why some are longer or shorter ________
____
____
____
____
____
____
____
____
____
____
____

Sources of Delay, Extra Trips, and Trouble Tickets at Marine Terminals

3. Please rate **overall sources of delay**, with 1 as the least serious and 5 as the most serious.
   - Public roads & highways 1 2 3 4 5
   - Marine terminal gates 1 2 3 4 5
   - Marine terminal yards 1 2 3 4 5
   - Other _______________ 1 2 3 4 5
4. Please rate **causes of non-revenue trip legs**, with 1 as the least serious and 5 as the most serious.
   - Gate turnaways 1 2 3 4 5
   - Chassis logistics ("Splits") 1 2 3 4 5
   - Dirty or littered empties 1 2 3 4 5
   - Import box not ready 1 2 3 4 5
   - Export box not accepted 1 2 3 4 5
   - Wrong information 1 2 3 4 5
   - Other_______________ 1 2 3 4 5
5. Please rate **causes of trouble tickets**, with 1 as the least serious and 5 as the most serious.
   - Customer information error 1 2 3 4 5
   - Terminal information error 1 2 3 4 5
   - Equipment problem 1 2 3 4 5
   - Driver error 1 2 3 4 5
   - Dispatcher/company error 1 2 3 4 5
   - Other_______________ 1 2 3 4 5
6. When you get a trouble ticket or have to visit the trouble window, how long do you usually wait for resolution before shifting to another container? ________ minutes
   - What percentage of the time can you shift to another container move? ______%
   - What percentage of the time does a customer delay a driver by insisting that the driver pick up or deliver a specific container that is causing trouble?_____%

Problems at Marine Terminals

7. At marine terminals, what **practices** cause longer turn times, more frequent trouble tickets, or extra trips?
8. At marine terminals, how often do those **practices** happen? _____% of trips
9. At marine terminals, what should they do **differently**?
10. What **customer practices** cause longer turn times, more frequent trouble tickets, or extra trips?
11. How often do those **customer practices** happen? _____% of trips

12. What should **customers** do differently?
13. What **steamship line practices** cause longer turn times, more frequent trouble tickets, or extra trips?
14. How often do those **steamship line practices** happen? _____% of trips
15. What should **steamship lines** do differently?

Thank you very much for your help with this survey.
Distributed by: ___________

NCFRP Project 14 Port Drayage Company Survey Form

The survey form given to drayage firms is reproduced below (response spaces have been deleted).

Please complete the following survey based on your experience in port container drayage. Your name and answers will be combined with the responses from all the other firms and kept confidential.

Key Issues

1. Are you a . . .
   - ❑ Dispatcher
   - ❑ Company Owner
   - ❑ Manager
   - ❑ Other ______________________________
2. In your experience, what are the major causes of congestion at marine container terminals?
3. What are the major impacts of terminal congestion and delays on drayage operations?
4. In the spaces below, please enter **the amount of time in minutes you would allow** for each type of move with no congestion, with routine congestion, and with peak congestion.

Expected turn time* in minutes for . . .	**Terminal Condition** No Congestion	**Terminal Condition** Routine Congestion	**Terminal Condition** Peak Congestion
Bobtail in/Load out			
Bobtail in/Empty out			
Load in/Bobtail out			
Load in/Empty out			
Load in/Load out			
Empty in/Bobtail out			
Empty in/Load out			
Empty in/Empty out			

*including time in line and time in the terminal

5. If these times are different at each terminal, please explain why some are longer or shorter.
6. What has been your experience with terminal appointment systems?
7. What has been your experience with TWIC to date?
8. Please rate **overall sources of delay**, with 1 as the least serious and 5 as the most serious.
   - Public roads & highways 1 2 3 4 5
   - Marine terminal gates 1 2 3 4 5
   - Marine terminal yards 1 2 3 4 5
   - Other _______________ 1 2 3 4 5

Problems at Marine Terminals

9. Please rate **causes of non-revenue trip legs**, with 1 as the least serious and 5 as the most serious.
   - Gate turnaways 1 2 3 4 5
   - Chassis logistics ("Splits") 1 2 3 4 5
   - Dirty or littered empties 1 2 3 4 5
   - Import box not ready 1 2 3 4 5
   - Export box not accepted 1 2 3 4 5
   - Wrong information 1 2 3 4 5
   - Other______________ 1 2 3 4 5
10. Please rate **causes of trouble tickets** (or visits to a trouble window), with 1 as the least serious and 5 as the most serious.
    - Customer information error 1 2 3 4 5
    - Terminal information error 1 2 3 4 5
    - Equipment problem 1 2 3 4 5
    - Driver error 1 2 3 4 5
    - Dispatcher/company error 1 2 3 4 5
    - Other______________ 1 2 3 4 5
11. When drivers get a trouble ticket or have to visit the trouble window, **how long do they usually wait for resolution** before shifting to another container? ________ minutes
    - What percentage of the time can they shift to another container move? ______%
    - What percentage of the time does a customer delay a driver by insisting on a specific troublesome container? _____%
12. What **marine terminal** practices cause longer turn times, more frequent trouble tickets, or extra trips?
13. How often do those **marine terminal** practices happen? _____% of trips
14. What should **marine terminals** do differently?

Steamship Line Practices

15. What **steamship line** practices cause longer turn times, more frequent trouble tickets, or extra trips?
16. How often do those **steamship line** practices happen? _____% of trips
17. What should **steamship lines** do differently?

Customer Practices

18. What **customer** practices cause longer turn times, more trouble tickets, or extra trips?
19. How often do those **customer** practices happen? _____% of trips
20. What should **customers** do differently?

Rail Intermodal Terminal Practices

21. What **rail intermodal terminal** practices cause longer turn times, more trouble tickets, or extra trips?
22. How often do those **rail intermodal terminal** practices happen? _____% of trips
23. What should **rail intermodal terminals** do differently?

Best Practices

24. What **marine terminal gate or other changes** have you experienced that improved drayage operations?
25. What marine terminal practices have you experienced that you would recommend as **"best practices"** for other marine terminals?

26. What drayage or dispatching **practices have you developed or learned from others** that help reduce turn times, trouble tickets, or extra trips?
27. **What else** should we know about? (Add pages if necessary.)

Thank you very much for your help with this survey.
Distributed by: ___________

Terminal Webcam Data Collection

Methodology

A number of marine terminals provide live views of their gates via webcams. These gate cameras are set up by the terminal operators to allow drayage firms to monitor the gate conditions. They are intended as a means of managing demand for the marine terminals, assuming that drayage firms will adjust their plans based on the real-time feedback of gate congestion. In this study, gate cameras were used to assess truck queues outside the terminal gates at two busy terminals in two different geographic regions. The placement and viewing angle of the cameras allowed measurement of the following:

- The gate processing time of each truck;
- The time the truck spent waiting outside the gate;
- The time lost when a gate closed for lunch;
- The level of congestion at a marine gate throughout the week; and
- The level of gate activity during off-peak, nighttime, and pre-opening hours.

The general method for all of these tasks was to manually capture a series of images and store them in Microsoft Excel for post-processing. That is, researchers copied the camera's view on a Web browser and then pasted the image into Excel. Thus, the number of images captured is a function of how fast the copy and paste task can be accomplished. Also, it is dependent on the refresh rate of the camera. Some cameras provide a live feed whereas others provide snapshots at a certain interval (e.g., 30 seconds). Table 3–1 provides some key statistics concerning the rate at which images were recorded at the two study terminals. Each recorded image includes a time stamp.

To measure the terminal's processing time, the time at which each truck left the gate area was recorded in the corresponding column in an Excel file. The gate processing time is simply the difference between the departure times of trucks in the same lane. Using this procedure, the study

Table 3–1. Image capture rates at marine terminals.

Terminal A					
Date	11/2/2009	11/10/2009	11/4/2009	11/5/2009	11/6/2009
Day	Monday	Tuesday	Wednesday	Thursday	Friday
Observation period (EST)	13:00-14:00	14:00-15:00	10:00-11:00	15:00-16:00	14:00-15:00
Number of images captured in 1 hour	309	533	428	514	540
Average rate (seconds per image)	11.65	6.75	8.41	7.00	6.67
Number of trucks processed	92	111	106	71	115
Terminal B					
Date	1/20/2010	1/21/2010	1/22/2010	1/25/2010	1/26/2010
Day	Wednesday	Thursday	Friday	Monday	Tuesday
Observation period (EST)	17:35-18:35	17:03-18:03	17:15-18:15	17:46-18:46	17:00-18:00
Number of images captured in 1 hour	116	159	163	166	153
Average rate (seconds per image)	31.03	22.64	22.09	21.69	23.53
Number of trucks processed	36	63	84	65	96

team was able to obtain the truck processing times for nearly all trucks. The exceptions arose when rain made it difficult to distinguish one truck from another.

Using the webcam method, one also can observe queuing time. The measurement is the difference between the time the truck joined the queue and the time that it left the gate area. A problem with some terminals is that, depending on the camera's position and angle, one may not be able to see the entire queue. This method was used to determine time lost due to lunchtime closure of the gate.

Finally, the webcam method also enables monitoring of gate congestion levels over an extended period (days/weeks). In this study, to determine how frequently and severely a gate was congested, for an entire week team members took snapshots of a marine terminal gate every hour that the terminal was open. The result clearly indicated the peak associated with the initial opening of the gate and higher congestion due to ship schedules. Photos also were taken of various terminals during the night to determine the level of queuing activity when the terminals were closed.

Recording the images in Excel facilitated subsequent analysis, which typically involved development of a frequency distribution of the results, as well as ordinary statistical measures including means and modes for the various data sets that were collected.

As illustrated in this work, the webcam method can be used effectively to obtain truck processing times, truck inter-arrival times, and truck queuing times, as well as early morning queuing, lunch hour queuing, and truck weekly arrival pattern. This method potentially can be used to perform more rigorous studies such as the effect of weather on gate operations and the impact of a change in the gate infrastructure (e.g., additional lane) or gate operations (e.g., appointment system). Additionally, the webcam method provides access to a greater number of terminals that may be practically impossible to study using the traditional field-based method.

Finally, although the webcam method offers many advantages, it does have a number of limitations. The camera lens could be blocked with water during stormy conditions. There were also cases where the camera was completely off target, possibly due to strong winds. Another reliability issue is that sometimes the camera stops working after normal duty hours. Depending on the camera's view, one may not be able to observe all lanes at some terminals or the end of a queue. The resolution of the camera is typically low, which can make image analysis difficult.

Marine terminals provide webcams for the use of truckers and customers. Publication of actual webcam images raises potential issues of confidentiality, ownership, and legality that should be addressed in advance.

Sample Webcam Study Results

At one terminal, the NCFRP Project 14 study team sampled gate processing time a different hour per day on five different days of the week (Figure 3–2). The result showed a median wait time of 4.3 minutes and an average wait time of 5.1 minutes.

Observations of the full service portion of the gate also were taken hourly for a week. In Figure 3–3, Congestion Level 0 means that the next arriving driver would be serviced immediately. Level 1 equates to a wait of 15 minutes or less. Level 2 equates to a wait of 15–30 minutes. Level 3 equates to an average wait of more than 30 minutes. The times are based on the average wait times determined in the initial stage of the analysis.

The graph shows that this terminal always has a substantial number of trucks waiting for the gate to open. For half of the week, gate queues are 15 minutes or less. The heavy pattern at the end of the week is due to the need to process a large number of export loads to meet ship departure schedules.

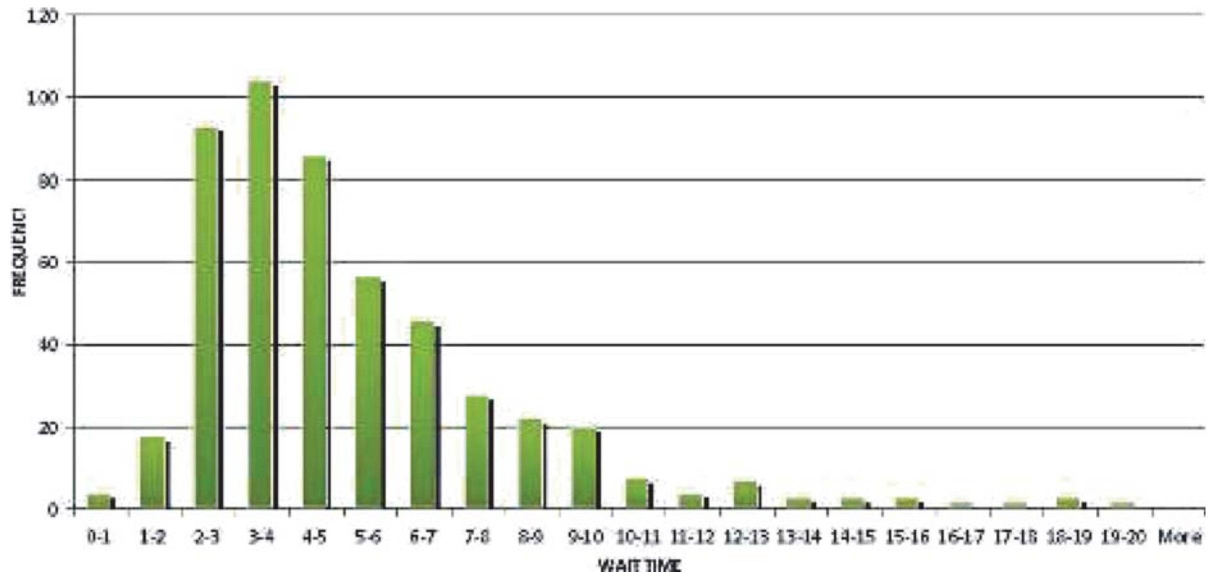


Figure 3–2. Gate waiting times from webcam study.

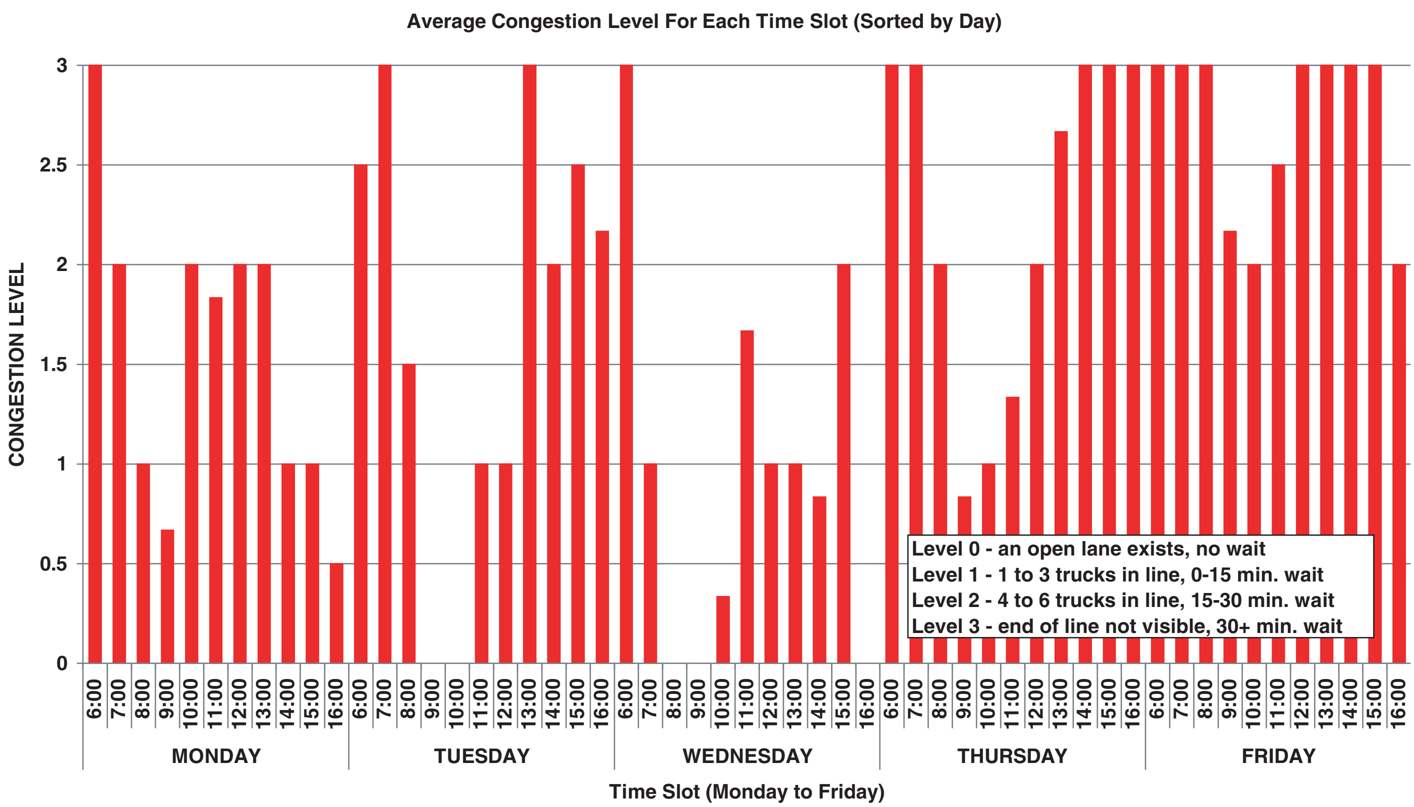


Figure 3–3. Webcam data on gate queuing.

Site Visits and Field Data Collection

Site visits to marine terminals and drayage firms are extremely valuable in understanding drayage operations and terminal interactions, and imperative for those unfamiliar with the details of local port operations. Considerable care, however, is required to arrange and conduct site visits.

Drayage firms are private commercial facilities. Appropriate contacts with drayage company managers will usually result in permission to observe dispatching and other operations. The mornings of busy days in peak shipping season can be extremely hectic, and the researcher may want to balance the educational value with the inconvenience to the firm in visiting during such times.

Marine container terminals are highly sensitive facilities in several respects, as follows:

- Safety—Marine terminals require all personnel to wear appropriate safety equipment and follow strict safety rules. Any visitors or observers in the operating areas of the terminals will be subject to the same requirements.
- Security—For unescorted access, anyone on a marine terminal must have a TWIC issued by TSA. Most visitors will be escorted at all times, even if they have a TWIC. Truck drivers are not allowed to have passengers in the cab. Anyone observing operations in the gate queuing area or outside the terminal will likely be challenged by security staff.
- Labor agreements—Longshore labor agreements govern any collection of data or use of technology in the marine terminals. Attempts to collect data or use equipment without express permission obtained in advance will almost certainly generate union concern.

There are three likely applications of field data collection for port drayage, as follows:

1. In-gate terminal queuing. Field observations of gate queuing would require multiple observers over many hours. The use of webcams or GPS/AVL systems are better alternatives for collecting gate queuing data.
2. In-terminal operational times such as hooking up a chassis or waiting in line for a lift machine. These fall into the category of classic "time and motion" studies.
3. Undocumented exceptions, such as turnaways or extra trips that are not recorded by terminal operating systems.

Collection of data in the field—at marine terminals, drayage firms, or rail terminals—is, however, costly, time-consuming, and subject to wide variability. For those reasons, the collection of data in the field should be focused on those information needs that cannot be met by other methods.

Special Studies

Of the various parties within the drayage industry, the ports are the only ones likely to undertake or commission special drayage studies or surveys, as shown in the following examples:

- Port of Houston Drayage Survey—The Port of Houston Authority sponsored extensive verbal surveys of drayage trucks in July–October 2008, with over 3,800 completed surveys. This effort was supplemented by a written survey taken July 31, 2008, with 183 completed responses.
- Port of New York and New Jersey (NY/NJ) Origin-Destination Studies—The Port of New York and New Jersey undertook an extensive drayage study in 2005 focused on understanding origin and destination patterns. This work updated a previous study completed in 1995. The survey used an extensive in-person questionnaire customized as required for individual port terminals.
- Ports of Los Angeles and Long Beach (LALB) Truck Trip Surveys—The San Pedro Bay ports have undertaken drayage driver surveys to determine the pattern of drayage trips. With trips

allocated to ZIP codes or to representative points within regions, such data can yield a weighted average distance to shipper/consignee locations.

- Port of Oakland Drayage Study—The Port of Oakland commissioned a drayage study to support the development of a clean truck plan. The report, prepared by Beacon Economics, was completed in April 2009. The Oakland study included surveys of licensed motor carriers (LMCs), drayage companies, and drayage drivers. Much of the survey scope concerned working conditions, driver demographics, and a comparison of employee drivers versus owner-operators. The study did, however, attempt to address fleet composition, distances traveled, trips per day, and terminal turn time.

Special studies, whether sponsored by a port authority or another party, frequently have the advantage of bringing substantial resources to bear on the issues. Such studies may, however, be limited in scope or timing. The container shipping and drayage industries are volatile, and can change significantly in a short time. The results of special studies must therefore be interpreted and applied with appropriate caution.

CHAPTER 4

Drayage Problems and Solutions

Problem and Solution Matrix

The NCFRP Project 14 study team developed a master matrix to systematically display salient study findings. The matrix displays the following information for the major bottlenecks and sources of delay identified in the project:

- Nature of the problem;
- Causes—proximate and root;
- Impacts, absolute and relative, on drayage time, cost, service, and emissions;
- Potential solutions;
- Implementation strategies;
- Potential implementation barriers;
- Roles and responsibilities of stakeholders; and
- Examples of successful implementation.

Table 4–1 displays the matrix.

The matrix provides a condensed overview of the major port drayage bottlenecks and sources of delay, and a starting point for analysis of drayage issues at specific ports and terminals. The significance of the problems in a nationwide context is displayed to help practitioners gauge the likely consequences of local issues and prioritize problem-solving efforts.

The major problem categories shown correspond to chapter headings in this guidebook.

Drayage Problems

The problems are displayed as rows, dividing the matrix into horizontal sections. The matrix is organized to identify four main problems and six aspects of the first problem as follows:

1. Long and unpredictable overall truck turn times at marine terminals,
   - Long and unpredictable marine terminal gate queuing
   - Marine terminal gate processing delays
   - Marine terminal procedural exceptions and trouble tickets
   - Container chassis supply time and delays
   - Marine terminal container yard congestion delays
   - Marine terminal disruptions
2. Extra drayage trips (“dry runs”),
3. Extra empty equipment moves, and
4. Congestion on streets and highways.

Table 4–1. Problem and solution matrix.

Causes		Impacts				Solutions				Implementation		
Proximate	**Root**	**Time**	**Cost**	**Emissions**	**Service**	**Practices & Example**	**Facilities**	**Technology & Systems**	**Institutions**	**Strategies**	**Barriers**	**Roles**
Summary Problem Statement: Long and Unpredictable Overall Turn Times at Marine Terminals												
Long queue times	Peaking	Average about 1 hour per transaction	24 million gate transactions annually	Significant avoidable emissions	Unpredictability makes it difficult for motor carriers to meet service standards	Recognize and address issue	Modernize	Effective electronic communication	Port community communication and collaboration	Shipper-driven communication, education, and cooperation	Suboptimization, motor carrier experiences most of cost	Improve communication, collaboration, proficiency, standardization
Gate processing delays	Gate capacity and hours											
CY delays	Chassis logistics, M&R						Adequate capacity			Continuous systems quality improvement	Logistics channel complexity	Marine terminals: problem resolution
Chassis logistics	Capacity shortfalls	5% of transactions take much longer	$1.2 billion of trucker time spent in marine terminals			Shipper-driven actions (e.g., this study)		Continuous quality improvement		Modernize & expand facilities	Marine labor agreements	Motor carriers: problem identification, cooperation
Problem resolution	Process Exceptions						Right technology			Enhance worker proficiency	Inexperienced drivers and carriers	
Congestion	Exceptions									Standardization	Some capital required	Shippers: drive the process
Problem: Long and Unpredictable Marine Terminal Gate Queuing												
Driver/truck arrivals exceed short-term gate capacity	Peaking	Avg. 20 min queue at inbound gate	$16.66 per inbound gate move	20 min of idling and creeping per move	Estimated standard deviation more than 30 min	Longer gate hours	Dedicated empty & chassis yards	Faster gate process	Port community communication	Continuous systems quality improvement	Suboptimization, motor carrier experiences most of cost	All--improve communication, collaboration, proficiency, and standardization
	Pier Pass					Remain open at meal times		OCR				
	Marine Terminal Capacity Management					Dedicated gates for simple transactions	Two-stage gates or equivalent	Video gate inspection		Modernize & expand facilities		Marine terminals--primary problem resolution
Variability in gate processing time	Lack of RPMs (outgate)	Times range from near-zero to multiple hours.	4-5 million annual inbound gate moves			Email, web, and/or gate camera information	High-tech gates	RFID		Enhance worker proficiency	Legacy facilities require capital to modernize	Motor carriers--problem identification, cooperation
	Gate closures for breaks		$67-$83 million nationwide		Problem worse at legacy gate facilities	Pre-cleared trucks	Nearby truck stops	Pre-Clearance with PINS	PierPass	Street turns		Shippers--drive the process
Morning queues	Lack of close overnight parking					APM Portsmouth example	RPM installation	Standardization		Appointment systems		Ports--port community communication
Problem: Marine Terminal Gate Processing Delays												
Slow gate processing	Slow legacy systems	Avg. 3-5 minutes per move	$1.00 extra per inbound gate move	Additional idling and creeping	At legacy gates a driver with a clean transaction can be delayed by other long transactions	Well-trained drivers and gate clerks	Two-stage gates or equivalent	Pre-clearance & appointment systems	Port-wide education and training	Execute existing procedures	Marine labor agreements	Marine terminals and motor carriers: training
Gate closures for breaks	Labor agreements & practices	5% of moves = 20+% of total time	4-5 million inbound gate moves per year							Automate, speed gate process		
Gate processing time variability	Exceptions					Fast diversion to trouble window for exceptions	High tech gates				Inexperienced drivers and carriers	Ports: information dissemination
	One-stage gates w/o bypass	Avg. move delayed by 1	$ 4-5 million annual extra				APM Portsmouth			Increase worker proficiency		Customer: choice of experienced truckers
Problem: Marine Terminal Procedural Exceptions, Trouble Tickets												
Dispatch errors	Changing conditions, inaccurate info	One hour driver delay for a trouble ticket	$50 per trouble ticket	Extra idling	One-hour delay per exception	Clean and timely customer booking		Continuous improvement to meet changing needs	Marine terminals communicate requirements and procedures clearly	Do it right the first time	Uneven procedural compliance by shippers, marine carriers, motor carriers, and marine terminals	All parties--more accurate, timely instructions and communications
Booking errors												
Marine terminal system errors	System flaws, customer practices, transaction complexity		5% of 24 million annual transactions			Proactive management of non-standard moves						
Driver error	Inexperience, error	Additional time for clerks, dispatchers, customers, and marine carriers	$60 million for motor carriers			Experienced, trained drivers, motor carriers, and clerks			Information and training for new and occasional drivers	Continuous exception reduction	Lack of easily accessible information on correct procedures	
Problem: Marine Terminal Chassis Logistics Delays												
Congestion at Chassis Yards	Limited chassis interchangeability	Average 12 min when driver must obtain chassis	$10 per chassis search	12 min of idling and creeping	Estimated standard deviation more than 5 min	Chassis pools	Right sized	Update legacy chassis management systems to keep up with legal and market trends	Chassis pools with greater participation and geographic scope	Let market forces continue to drive a transition to improve chassis management	Traditional chassis supply approach	Pool operators continue to expand operations
	Poor maintenance		Applicable to grounded terminals									
Waits for lift or flip	Frequent chassis changes											Motor carriers own more chassis
Chassis supply exceptions	Time to locate, inspect, and hook up chassis		20-30% of all containers			Trucker-owned chassis	Dry, well organized, maintained, and lighted		Continue to implement FMCSA roadability regulations	Safety regulation	Undercapitalized motor carriers	Marine carriers provide fewer chassis
			$2-4 million annually									

Causes		Impacts				Solutions				Implementation		
Proximate	**Root**	**Time**	**Cost**	**Emissions**	**Service**	**Practices & Examples**	**Facilities**	**Technology & Systems**	**Institutions**	**Strategies**	**Barriers**	**Roles**
Problem: Marine Terminal Container Yard Congestion Delays												
Congestion in the container yard	Gate flow/container yard imbalance	Delays inside and outside terminal	Avg. $8.33 per inbound gate	10 min of idling and creeping	Unpredictable, unreliable service	Maintain gate flows in balance with the rest of the marine terminal's capabilities	Densify the marine terminal	Increase container handling automation		Facilities, equipment investment	Legacy facilities require capital to modernize and densify	Marine terminal must invest or work longer to increase capacity
	Insufficient container yard capacity or lift	Inside gate turn times vary by 20-30 min with congestion	4-5 million inbound gate moves per year				Additional terminal equipment				Appointment systems have some promise but have not yet been used successfully to significantly smooth work flow	
	Uneven flow and peaking in CY	Estimate 10 min per inbound gate	$33-$42 million annually nationwide			Longer terminal hours	Off terminal chassis and container yards			Smooth work flow		
	Equipment location problem (UTL)											
Problem: Marine Terminal Disruptions												
Inefficiency	Process or facility changes	One extra hour or more for motor carriers forced to use the disrupted terminal.	$50 per trip	One extra hour of idling and creeping	Major delays for both disrupted terminal and other terminals served by the same truckers	Crisis management teams	Add temporary facilities	Redundant system	Communicate nature and details of crisis and remedies	Add resources; typically land and labor	Disorganized, congested facilities	Marine terminal--problem resolution
Systems failure	Management changes		Estimate one terminal disruption annually									
Natural disaster or accident	Ocean carrier tenant shifts		250,000 trips per terminal			Shift of resources						
	Sudden increase in volume											
Short-term terminal performance lapse	Strikes		$12.5 million annually			Longer terminal hours						
	Short-term interruptions											
Problem: Extra Drayage Trips, "Dry Runs"												
Dispatch or driver error	Poor communication	Varies depending upon distance; assume 2 hours	$ 100 per occurrence	Extra miles and idling	Missed customer appointments	Proactive dispatchers		Continuous improvement to add shipment visibility	Communicate when exceptions arise	Increase worker proficiency	Inexperienced workers	Motor carrier--problem resolution
Booking error	Poor communication, customer error		0.1% of containers			Make use of available systems					Inaccurate systems	Support by others to provide accurate information.
Terminal error	Poor Communication, system error		$1.2 million annually			Well-trained clerks and drivers					Procedural discrepancies	
Problem: Extra Empty Equipment Moves												
Empty equipment in wrong location	Vessel Sharing Agreements	Extra drayage moves within port complex	$75 per move	Extra moves	Delay in empty positioning	Marine terminals and carriers direct return of empty equipment to different locations		Daily communications with motor carriers using a variety of latest technology; web, email, etc.	New UIIA provisions add flexibility	Improve equipment distribution practices to take advantage of new flexibilities	Traditional practices	Marine carriers--primary problem resolution
	Chassis pools		Estimate 1% of containers									
	Ocean carrier tenant shifts	Assume 1.5 hours per move	$9 million annually								Terminal congestion	
	Human error											
Problem: Congestion on Streets and Highways												
Recurring congestion	Highway capacity shortfall	Significant, unable to quantify the time penalty	$50/hour	Extra idling and creeping	Missed customer appointments	Motor carrier dispatch to avoid congestion	Build/expand key intermodal connectors	Traffic monitoring systems	Port community active in highway planning	Proactive port community advocacy to gain share of highway improvement funds	Difficult, time consuming	Port Authority--leadership role
	Road condition problems		10% penalty on 4 hour driving day									
Nonrecurring incidents	Congestion, inability to recover		$25 per day			Minimize operations during peak hour		Webcams			Long-term effort	Port community--strong political support
			$150 million annually									

The problem descriptions are relatively generic, and are discussed in detail in relevant sections of this guidebook. Although the potential for delay and unreliability exists at rail intermodal terminals, off-terminal container depots, and shipper/receiver locations, those sources of delay were considered relatively minor. They could, however, have local or short-term significance.

Marine container terminal turn time is the principle focus. The matrix shows it as an overall problem, and then provides separate entries for the six turn time components listed in Table 4–1. The problems covered have both time and reliability dimensions, which can be equally important.

The problems are interrelated in complex ways. Taking chassis pools out of marine terminals, for example, will reduce associated delays, but may entail extra trips to position chassis outside the terminal. It is, therefore, more useful and accurate to view the matrix as a system rather than as a checklist of independent issues.

Causes

The causes section of the table is broken into two sections: "proximate" and "root." The proximate cause may be thought of as the manifestation of the root cause. For example, long queue times is the symptom of a root problem such as peaking, legacy facilities, or poorly trained clerks. The distinction follows conventions commonly used in process improvement efforts, and has been adopted for that reason. Many of the proximate causes of delay, such as long gate queues or congestion at chassis yards, are immediately obvious, but the root causes are not. Moreover, some proximate causes, such as slow average gate processing times, may have multiple contributing root causes such as legacy systems, meal breaks, or inability to divert exceptions to a trouble window. A substantial part of the project effort was devoted to linking proximate and root causes, and understanding the root causes.

There are also root causes—such as peaking, communications shortfalls, and human error—that contribute to multiple problems. That is not surprising considering the interrelated nature of the system. For those structural factors that are an inherent part of containerized shipping, such as peaking, the matrix suggests that some problems will persist and can be reduced but not eliminated. Human error can likewise be reduced through training or better information, but cannot be eliminated. The matrix also suggests, however, that efforts directed at better communications, systems improvement, training, and other common issues will have multiple payoffs.

Impacts

The impacts section of the table categorizes the problems based on their adverse impact on drayage time, direct economic cost, emissions, and service quality. All the impacts are rough estimates for the purpose of showing order-of-magnitude results.

The time impacts shown range from a few minutes per move due to gate processing delays, to an average of about an hour per move for trouble tickets or comparable exceptions. Since drayage costs are primarily a function of time, the time impacts drive the cost estimates. The most dramatic impacts are those associated with the "tails" of the turn time or gate time distributions—the 5% of transactions that take much longer than average. There have always been anecdotal reports of multi-hour turn times or queue times, but they have not been previously quantified. Service impacts are estimated based on the magnitude or the variability in process times introduced by the particular problem or issue.

These estimates provide guidance on the absolute and relative importance of the various problems.

- The overall cost of driver and tractor time spent in marine container terminals is estimated at over $1 billion annually. (The total cost of drayage is much higher, because it includes time in transit and at customer locations, as well as time at the ports.)
- Queuing at the marine terminal gates is estimated to cost $67–$83 million annually, while gate processing delays add an estimated $4–$5 million to the total.
- Exceptions and trouble tickets are a major cost factor, with an estimated impact of $60 million annually.
- The additional cost of obtaining chassis at a stacked terminal, as opposed to arriving with a chassis, is estimated at $2–$4 million annually.
- Congestion in the container yard is estimated to cost drayage firms about $33–$42 million annually.
- Congestion cost on highways and streets is impossible to quantify with any precision. The matrix provides a plausible estimate of around $150 million annually, based on 10% of 4 hours of driving per day (as opposed to time waiting) or 24 minutes per day of lost time due to congestion.

Service impacts are qualitative, with most problems resulting in delays or missed appointments.

Most delays result in extra time spent idling or creeping in queues in terminals or on congested roads.

The emissions impacts of those delays have been estimated using the EPA SmartWay DrayFLEET Model, as explained in detail in Chapter 12.

Solutions

Potential solutions to drayage problems also are identified in the matrices. In general, they encompass steps to mitigate peaking and congestion, and reduce exceptions and trouble tickets as follows:

- Better use of port and terminal information systems to ensure that import containers are ready to be picked up;
- Two-stage terminal entry gates (or equivalent capabilities) to segregate and handle exceptions without delaying routine transactions;
- Appointment systems that can make terminal transactions more predictable and reduce gate and container yard congestion;
- In the near term, neutral chassis pools to streamline in-terminal chassis logistics;
- In the long term, trucker-supplied chassis to eliminate in-terminal chassis logistics;
- Extended gate hours, where required, to reduce and accommodate peaking;
- Better driver and drayage firm information and training;
- Importer and exporter preference for experienced drayage firms that understand and use the available productivity tools;
- Rationalization of empty container and chassis return requirements;
- Wider use of OCR, RFID, and other technologies to automate, streamline, and routinize terminal gate processing;
- Proactive chassis maintenance and flagging of defective chassis in terminal pools;
- Elimination of gate closures for lunch or other breaks;
- Improved accuracy of exporter booking instructions and documentation;
- Correction of terminal systems "glitches" that lead to trouble tickets or dysfunctional work-arounds;

- Regular meetings and other communication within the port community, including port staff, terminal operators, drayage firms, ocean carriers, customers, and other stakeholders as required;
- Sufficient terminal resources and capabilities to simultaneously serve vessels and trucks;
- Customer preferences for ocean carriers with good drayage transaction records;
- Reduction in port-area and urban street and highway congestion; and
- Improvements to legacy marine terminals.

Implications for Stakeholders

A review of the matrices, the list of problems, and the list of solutions suggests roles for all of the stakeholders in containerized shipping and port operations as follows:

- Port authorities can improve communications, support legacy terminal improvements, coordinate appointment systems, and participate in port-area congestion mitigation.
- Marine container terminals can improve gate processing, reduce operating system "glitches," stagger break times to prevent gate closures, extend gate hours as required, and increase capabilities to simultaneously serve vessels and trucks.
- Drayage firms can increase their driver training effort, maximize use of port and terminal cargo clearance systems, and work with customers to reduce booking errors.
- Ocean carriers can rationalize empty returns, reduce booking errors and exceptions, and support terminal improvements and extended gates.
- Customers can reduce booking and paperwork errors, and use experienced, knowledgeable drayage firms.
- Local and regional planners can mitigate congestion on port-area streets and highways.

Although each stakeholder group can achieve marginal improvements working independently, large-scale solutions will require coordinated efforts by multiple parties.

CHAPTER 5

Truck Turn Times

Terminal Versus Overall Turn Times

The key measure of drayage performance within the terminal is *turn time,* the time required to complete an activity cycle. In the large picture, turn time refers to the entire round-trip movement between port and customer or rail terminal. Those turn times are, however, customer specific and location specific, and influenced by distance, highway conditions, business practices, drayage strategies, etc. There are two different turn times associated with marine terminal visits, as follows:

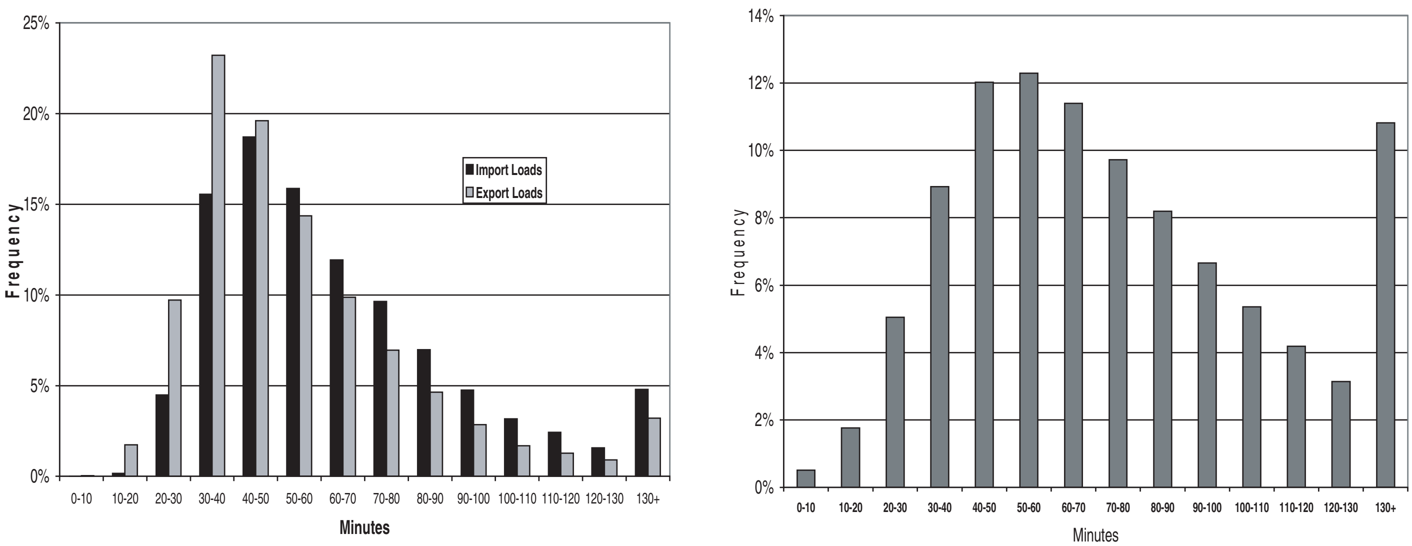
- The *terminal* turn time recorded by the marine terminal is gate to gate, triggered by arrival of the drayage driver at the entrance gate and ended when he leaves the exit gate. These recorded turn times range from a minimum of about 10 minutes for a completed simple transaction to as much as 8 hours. Marine terminals have no data on drayage activity outside those gates.
- The *overall* turn time experienced by drayage drivers, however, includes queuing time before they reach the terminal gate itself. The additional time spent waiting outside the entrance gate has been reported in various surveys to be as long as 2 hours. The study team observed waiting times ranging from effectively zero when there was no queue, to 4 hours or more when terminal operations were severely disrupted.

Turn Time Distributions

Gate-to-gate terminal turn times typically show, as expected, a skewed distribution (Figure 5–1). The first terminal shows a few unusually quick transactions of less than 30 minutes, a large number of "normal" transactions of 30–60 minutes, and a few much longer transactions that reflect exceptions. The second, more heavily used terminal shows somewhat longer turn times but the distribution has the same overall shape—skewed toward the longer turn times by exceptions. The "normal" time varies with the complexity of the transaction and the type of terminal.

Figure 5–2 compares a distribution of port-wide trucker turn times (includes queuing) with terminal turn times (does not include queuing) from one of the terminals in the same port. Although the comparison is not precise, the available data suggest that the trucker's turn times typically include 20–30 minutes of queuing time, shifting the distribution to the right.

The critical factor is the common *shape* of the distributions in Figure 5–1 and Figure 5–2. In each case there are roughly 5% of the trips in the extended right-hand "tail" of the distribution that experience much longer turn times and account for a disproportionate share of drayage time, cost, and emissions. The system is effectively operating at "two sigma," with about 95%



(a) Terminal 1.

(b) Terminal 2.

Figure 5–1. Gate-to-gate turn time distributions.

of the transactions (about two standard deviations from the mean) in the expected range and 5% outliers.

Turn Time Components

Most terminal turn time data are not segmented, so only the total turn time is available for each transaction. One of the case study terminals, however, made segmented data available for import deliveries, as shown in Figure 5–3. Figure 5–3 shows clearly that most of the time at the terminal (once past the queue) is spent in the calendar year (CY). For modern terminals with a high degree of gate automation, the actual time spent at the gates is usually only a few minutes.

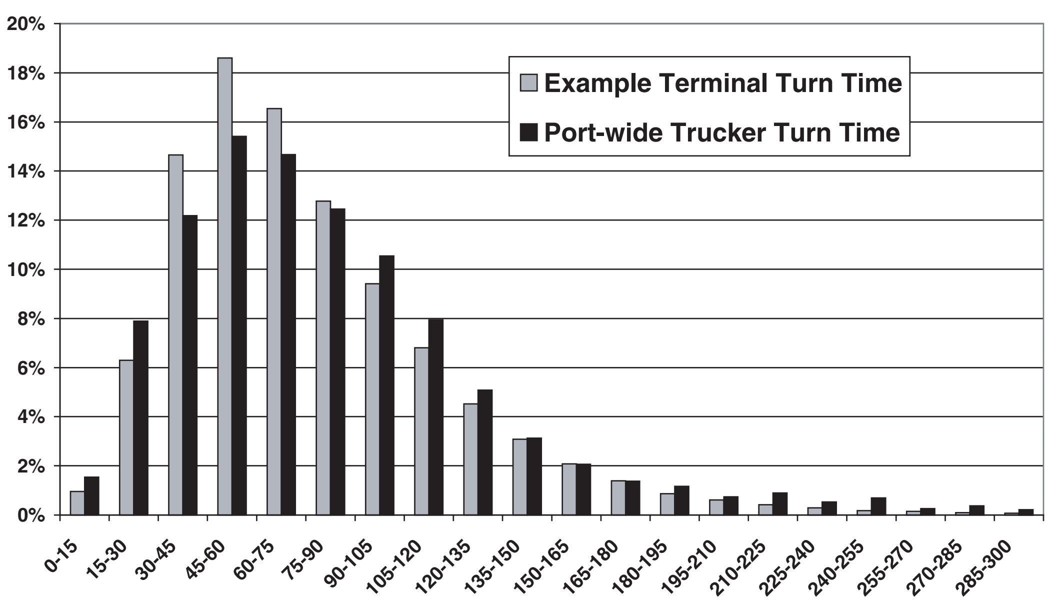
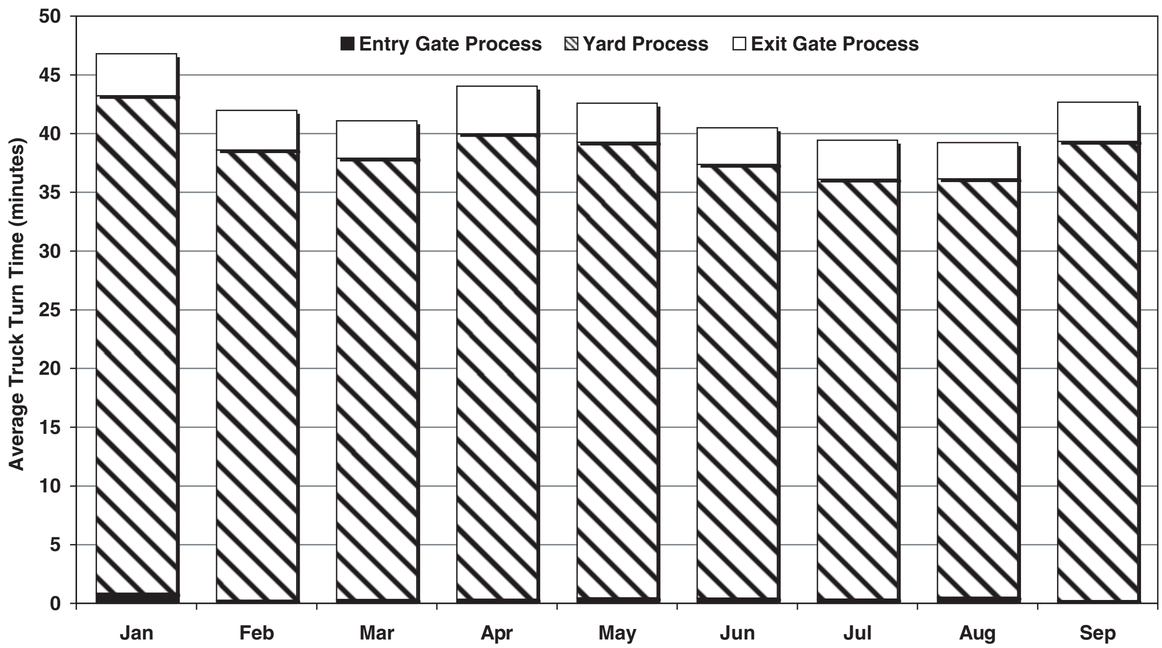


Figure 5–2. Trucker and terminal turn time comparison.

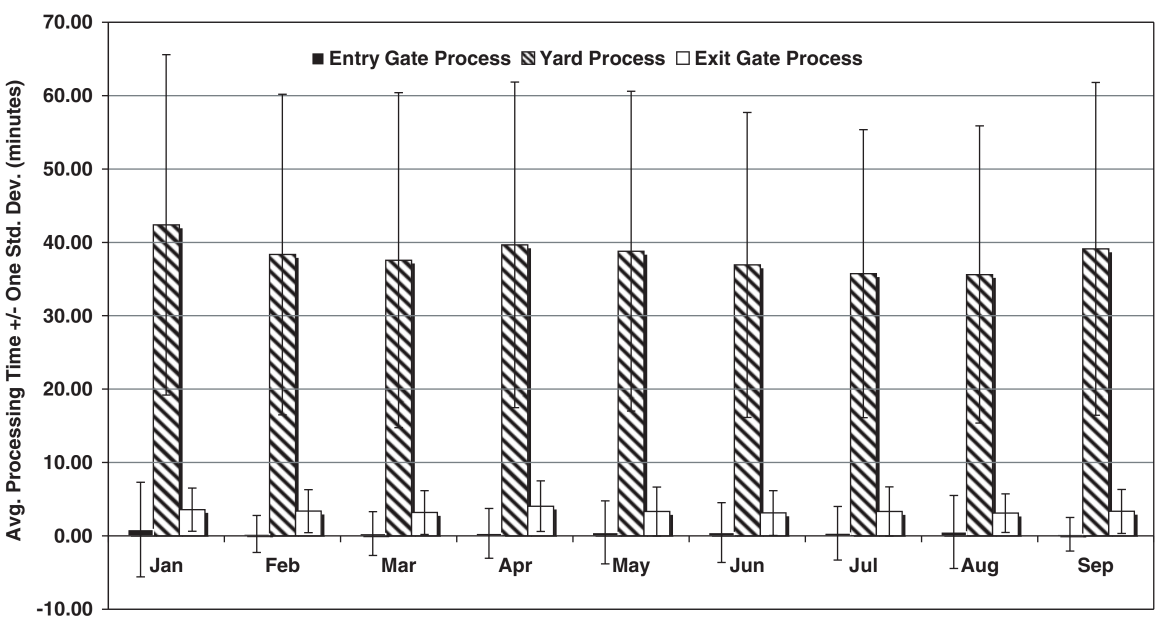


Source: Port terminal data, outliers removed.

Figure 5–3. Drayage turn time segments.

Figure 5–4, from the same source, shows that the variability of the CY process is also far greater than the variability of the gate processes. Accordingly, CY processes are a major focus for identifying potential bottlenecks.

The relatively small amount of time spent at the gate itself might seem to diminish the importance of gate processing in attempts to reduce turn time. Gate processing times, however, determine outside queue times when trucks arrive faster than they can be served. Each unnecessary minute at the gate is multiplied by the number of trucks in line.



Source: Port terminal data, outliers removed.

Figure 5–4. Terminal turn time variability by segment.

Within the terminal, the major determinants of turn time are as follows:

- The nature of the transaction,
- On-terminal chassis supply,
- Congestion in container stacks or parking areas, and
- Exceptions and trouble tickets.

Causes of Long Turn Times

Congestion at marine terminal gate queues and container yards is primarily caused by peaking, and can be exacerbated by limitations on working hours, external factors such as the OffPeak Program, or shortcomings of legacy facilities.

- Longer turn times can be expected for more complex transactions. Truckers prefer “double” moves (e.g., returning an empty container and pulling an import load on the same trip) rather than making two trips for the same work.
- On-terminal chassis supply is a focal point for process improvements and long-term institutional change, and is discussed in more detail later in the guidebook.
- Congestion in container stacks or parking areas is a function of terminal CY capacity, lift capability, configuration, and peaking. Peaking is endemic in containerized shipping, and it would be impractical to build terminal capacity for the peak volumes. The bigger issue is the division of lift capabilities and staffing when vessels are in port.
- Exceptions and trouble tickets add an average of about an hour to affected moves. At about 5% of the total, trouble ticket transactions add about 3 minutes to overall average turn times.

On a given day, turn times for trucks can vary substantially, even when trucks enter the terminal under similar conditions. There are a number of factors that can extend the time required. The average (mean) daily turn time may provide very little information about what is possible for any individual truck that day. When a terminal is operating close to its capacity, the probability of high turn times significantly increases. In examining the patterns of delay throughout the day, the researchers found that turn times tended to come down later in the afternoon as the number of arrivals dropped. Furthermore, the probability of a truck experiencing an extra long turn time was lowest toward the end of the day. It should also be noted that the capacity of a terminal is dependent not only on the physical attributes of the terminal such as the number of lanes and cranes, but also the amount of labor that has been assigned to work a particular shift. Terminals attempt to anticipate high-volume periods and assign labor accordingly. If the terminal misjudged the volume for a particular day, higher average turn times and greater variability can result.

The impact of congestion can be seen in the relationship between volume and turn times in Figure 5–5. Although the general relationship is clear, the specifics will vary by terminal. In the examples, the first terminal is relatively unaffected by volumes of up to 1,100 per day while the second shows marked increases in turn times for volumes above that level.

Suboptimization

A substantial portion of the delays and bottlenecks in port drayage are traceable to suboptimization of the complex intermodal system. Drayage firms and marine terminals would both prefer an even, predictable, and uninterrupted workload over the day, week, month, and year. The context in which they operate, however, makes that unlikely to ever happen. A system optimized for the drayage customers (the importers and exporters) is unlikely to be optimal for the marine terminal customers (the ocean carriers).

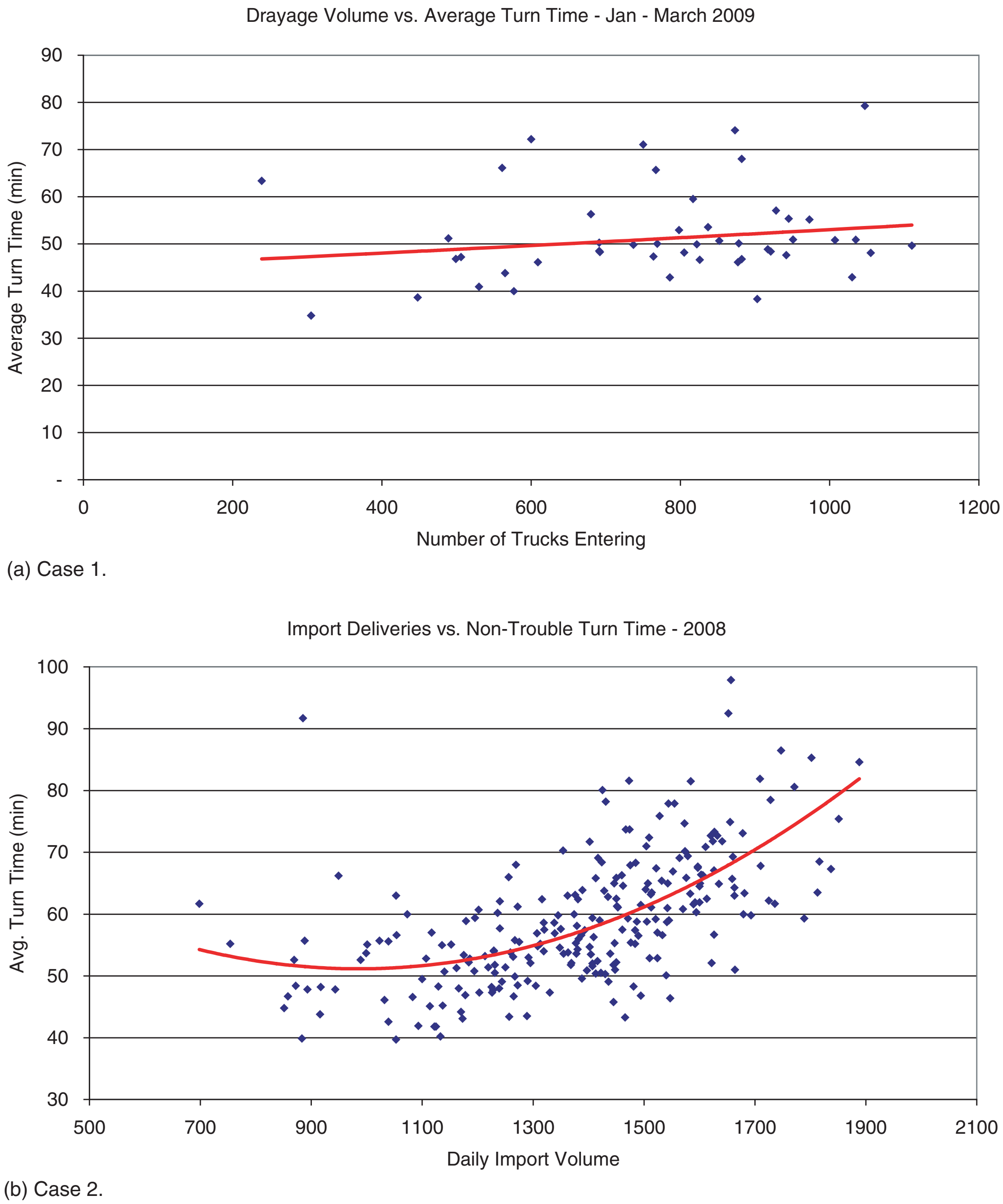


Figure 5–5. Congestion impacts.

There is no one in charge of the entire process, so rational and well-informed actions by participants still do not optimize the whole.

It is helpful to place drayage and terminal operations in context. Drayage of marine containers to and from port terminals is a complex process involving interactions between customers (importers, exporters, 3PLs), ocean carriers, terminal operators, and trucking firms. The fundamental transaction is between the ocean carrier and the customer, with the customer paying for waterborne transportation of the goods inside the container. Marine terminal operations and drayage are intermediate steps, and both must cope with the movement preferences, policies, and capabilities of the ocean carriers and their customers. This intermediate position requires both drayage firms and marine terminals to cope continually with unevenness of demand, inconsistent priorities, mismatched information flows, and cost pressure.

The direct customers of the drayage firms are usually the importers and exporters. (Although so-called "store door" drayage is theoretically controlled by the ocean carriers, in practice, the importers and exporters often chose the drayage driver.) The primary goal of importers and exporters is to obtain their import goods (or ship their export goods) at their preferred time at lowest possible cost. Customers see the cost, time, and uncertainty associated with drayage and seek to minimize all three, but are first and foremost concerned with the cost.

The direct customers of the marine terminal operators are the ocean carriers. Although marine terminal operators do pay attention to the needs of importers, exporters, and drayage firms, the ocean carriers pay the bills. Many marine terminal operators, such as Eagle Marine Services and APM Terminals, are ocean carrier subsidiaries. The primary goal of the ocean carriers is to turn the ship (unload import boxes and load export boxes) on schedule at lowest possible cost. Carriers will pressure terminal operators (even their own subsidiaries) to handle the vessel on schedule at lowest possible cost, regardless of impacts on other terminal functions—notably drayage. As a result, drayage queues lengthen and turn times rise while a vessel is being worked.

Although the ultimate customer pays the entire cost, that customer does not see all the component parts or the tradeoffs between them. An importer with a "store door" rate will receive a single bill from the ocean carrier, with no breakdown between ocean, terminal, and drayage costs. An importer or exporter with a "local" rate will pay for drayage separately, but will not see a breakdown between terminal and ocean costs.

Need for Buffers

Vessels arriving at the terminal unload a large number of containers in a relatively short time. The vessel arrival therefore creates a backlog or stockpile of import containers on the terminal, which draymen will pick up and deliver over the next few days. Vessels departing the terminal likewise load a large number of outbound containers in a relatively short time, clearing the terminal of a backlog that draymen created by delivering export loads and empties over the previous week.

The desire and ability of import customers to receive containers may bear little relation to the pattern of vessel arrival. One customer may want "hot" boxes immediately, while another may want arrivals spaced out over several days. At most ports the typical pattern is for import pick-up demand to peak on the day of first availability (usually the vessel arrival day), and to taper off thereafter. Empty container returns will lag import pickups by a day or more. Export loads typically build up in the week prior to vessel arrival, often peaking the day before the outbound cutoff.

The flow of containers between vessel and landside customer is therefore anything but smooth. Rather than a steady conveyor-like stream, the flow is a series of surges.

Any system that must accommodate uncoordinated flows and surges requires buffers—intermediate stopping or storage points that allow parts of the system to operate at different rates or on different schedules. As a buffer, however, the gate queue is costly, inefficient, and environmentally unsound. Each container in a terminal gate queue is being attended by a driver, chassis, tractor, and diesel engine burning fuel and emitting pollutants. Best practices should conserve some or all of those resources by minimizing the time in the queue.

The potential for uneven arrivals, the fixed throughput capacity of the gates and the terminal, and the relative difficulty of adapting the number of open gates together imply the need for a buffer in the system. The marine terminal gate acts as a metering device, with the queue outside serving as a buffer. Appointment systems reinforce this metering function. Terminals make only as many appointment slots available as the CY can handle. The gate queue is currently functioning as the buffer. Some sources refer to the queue as the "holding pen," which is an accurate, if somewhat unflattering, description.

Turn Time Solutions

Terminal Capacity and Performance

With such a large part of drayage inefficiency and delay traceable to congestion, terminal capacity and performance is a logical place to look for improvement. Annual terminal throughput capability is less important in this connection than ability to handle surges.

In particular, the ability of a terminal to sustain efficient high-volume trucking operations at the same time a vessel is being served is crucial, and often lacking. It is common to reduce the scope of drayage transactions while a vessel is being worked, either by restricting operations, such as empty returns, or by closing off busy areas of the terminal. Drayage drivers may find gates understaffed, lift machines busy, and clerks preoccupied with other tasks on vessel days.

One promising approach is to design the terminal so truck and vessel operations do not overlap or share equipment. The APM Portsmouth terminal and the proposed Ports America terminal for Oakland are examples of designs with container stacks perpendicular to the vessel. These stacks are served by one set of gantries to load and unload the vessel from the berth end, and by a second set of gantries to load and unload drayage trucks on the CY end.

Such large-scale investment and reconfiguration is beyond the short-term need and capability of most port terminals. More modest means of improvement would include enough efficient lift equipment and staffing to handle both vessels and trucks in existing configurations.

If the gate throughput capacity is the same as the terminal CY throughput capacity, there may be no point in speeding up the gates, since it would merely result in CY delays instead. From the terminal's perspective, there is no need to improve gate throughput since, as long as there is one limiting factor, overall efficiency is compromised. However, from the drayage driver's perspective, they would still like to see congestion-free gates because then they at least have a chance of getting through within an acceptable time window provided they are not particularly unlucky within the terminal.

If the gate capacity is less than the terminal capacity, then the gates are a bottleneck and a case can be made for speeding them up or opening more when a queue develops. Speeding up the gates through institutional or technological means is probably a long-term solution and would apply to all days and all gates. Likewise, building more gates would be a long-term endeavor.

Port Community Meetings

Regular meetings between port or terminal officials and major dray companies are an effective strategy for identifying bottlenecks and inefficiencies. The introduction of Web-accessible terminal information also has been an effective strategy for providing dray companies and drivers with greater information as to port processes.

The working relationship between all of the parties involved improves with regular contact and communication. Although terminal operators do not earn more revenue for faster drayage turns, they do bear the additional costs for clerical handling of trouble tickets and additional CY staffing or equipment to handle congestion.

For over 20 years, the Port Authority of New York and New Jersey (PANYNJ) has been convening semi-monthly port user group meetings. These meetings include ocean carriers, marine terminal operators, International Longshoremen's Association (ILA) representatives, drayage firms, customers, and third parties. The meetings provide a venue for announcing and discussing planned developments and changes, solving problems, and forging an ongoing working relationship between the parties. In the observation of the research team, these meetings have resulted in a far better mutual understanding of concerns and goals. The longevity and regularity of these meetings also has given the Port Authority and its staff much deeper insight into the operations and concerns of the port community than would be gained from occasional issue-based meetings.

The Port of Houston Authority also has convened periodic meetings with drayage firms and both parties report these meetings to be valuable and productive.

Such meetings do not solve every problem. The differing interests and goals of the parties make some degree of conflict all but inevitable. The meetings do facilitate solutions when solutions are possible, and encourage cooperation and communication on other less controversial matters.

Segment by Segment Improvements

Overall turn times are made up of multiple time segments: gate queuing, gate processing, chassis supply, CY operations, etc. Each of these time segments is treated in the guidebook chapters that follow. A comprehensive approach to drayage turn time reduction would entail identifying and prioritizing the drayage activity segments with the greatest delays and addressing them individually. Care must be taken, however, to acknowledge and manage tradeoffs.

CHAPTER 6

Marine Terminal Gate Queuing

Entrance Gate Issues

The entrance gate queues at marine container terminals have long been identified as bottlenecks and sources of delay for port drayage. The process for entering a marine terminal is more complex than exiting, and queues are common for drivers seeking to enter. These entrance gate queues at marine container terminals serve as buffers between the marine terminal operation and the demands of customers. Time spent in the queue is unproductive, and idling in the queue is easily identifiable as a significant source of unnecessary emissions and noise. In slack periods, drivers often can drive directly to the gate itself, with no time in the queue. On the other extreme, drivers at some terminals frequently have reported queue times of 2 hours, with anecdotal reports of even longer waits.

A driver's decision to join a queue at any given moment (or the dispatcher's decision to send the driver to the terminal) is a complex mixture of free choice and compulsion depending on the following:

- The dispatcher and driver's experience-based estimate of how long will be spent in the queue. A significant number of drivers are not regular port visitors.
- The driver's options for waiting, taking another assignment, stopping for a meal, quitting for the day, etc. Motor carriers balance the customer's service requirements with ship schedules and terminal capacity limitations.
- The driver's expected revenue under various options.
- The time remaining in the driver's working day.

It is critical to observe that motor carriers and drivers are rational, profit-motivated businesses. When they join a long queue, it is likely the optimal decision for that company and driver at that time, given the information available.

Most drayage drivers are paid by the move, not by the mile or by the hour. If they already have a container that is headed to the port (e.g., they have picked up an export load or an empty from an import load), it is likely that it would be time consuming (and therefore costly) to exchange that unit for another assignment. Waiting until the queue goes down yields no revenue, and may reduce the number of moves the driver can make that day. With a very narrow range of revenue-generating alternatives, it is usually in the driver's best interest to join the queue, even if it is a long one.

Usually, there are no satisfactory data available on queuing times. Terminal information systems do not capture queue times. Almost all the data available in the literature are from driver surveys. Since these are the products of drivers' memories, impressions, and estimates rather than actual measurements, these data are not usable in any kind of rigorous analysis. Researchers rarely have access to data on internal terminal activities when performing gate surveys, so the survey data are rarely linked to volumes, arrival distribution, transaction types, number of gates, type of gate, or other information that would facilitate an analysis of cause and effect. Most surveys ask for overall turn time, and do not separately identify gate queuing time. Moreover, given the number of factors that affect dray turn time, a simple average is of little use. A more accurate and insightful analysis requires identifying the variability in queue times and the reasons for that variability, which, in turn, requires a distribution rather than an average.

Driver/Truck Arrivals

The number of drivers and trucks arriving during a given time period varies with the volume of work to be done and the choices made by drivers, customers, and dispatchers. As long as vessel arrivals and departures and customer shipping and receiving practices result in peaking, it is probably impossible to eliminate queuing congestion and delays completely.

The arrivals at the gate vary by day of week. At one terminal, sample data show Friday to be the busiest (Figure 6–1). Other port and terminal data generally show heavier activity toward the beginning of the week, or show different distributions with more extreme peaking. These day-of-week variations should be predictable and accommodated. The pattern of arrivals over the week depends on vessel schedules and customer choices. Customers are notified when vessels arrive and their import containers are unloaded. They, in turn, notify the drayage driver and typically want the import boxes quickly, often on the same day as unloading. The rush to get newly unloaded import containers accounts for peak queues on vessel arrival days. Similarly, there is an export peak as vessel departure day approaches, and exporters work to get their outbound containers to the marine terminal before the vessel cutoff time.

Figure 6–2 shows hourly arrival patterns at Bayport, Port of Houston, for July 2009. The peak days were Tuesdays, with the peak hours being in the middle of the morning.

Consistent daily peaking is also typically observed. It is common to observe long queues before the gates open in the morning and during lunch and coffee breaks. Since both drayage firms and their drivers are usually paid by the move, they have an incentive to make as many moves as possible as soon as possible. A driver who starts early has a better opportunity to make more moves and earn more revenue than a driver who is less aggressive. Long-distance drivers arriving in the port area in the middle of the night often prefer to wait overnight in the marine terminal queue area so they can continue their trip as early as possible the next day.

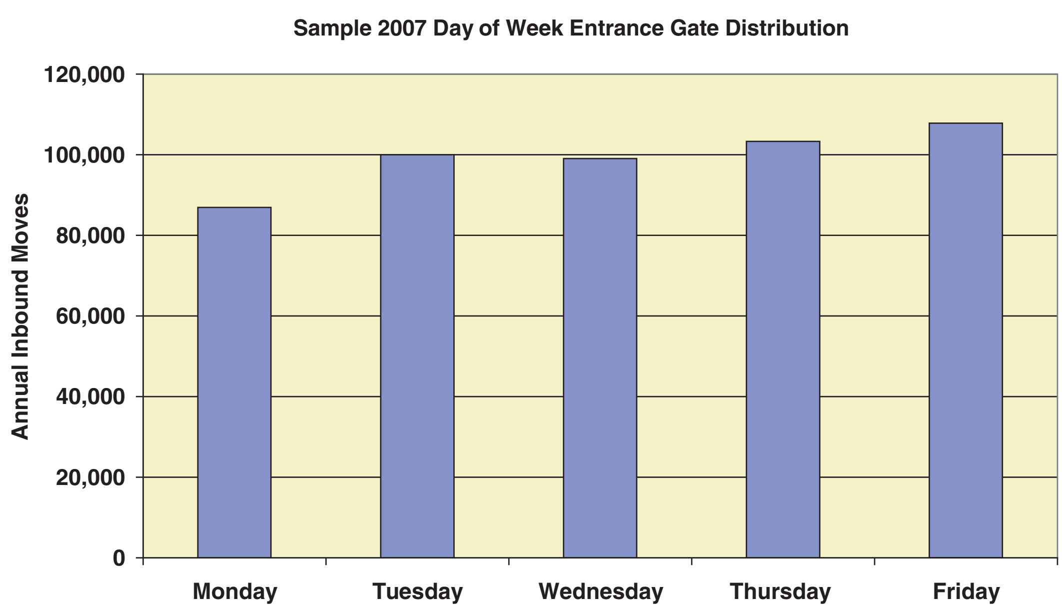
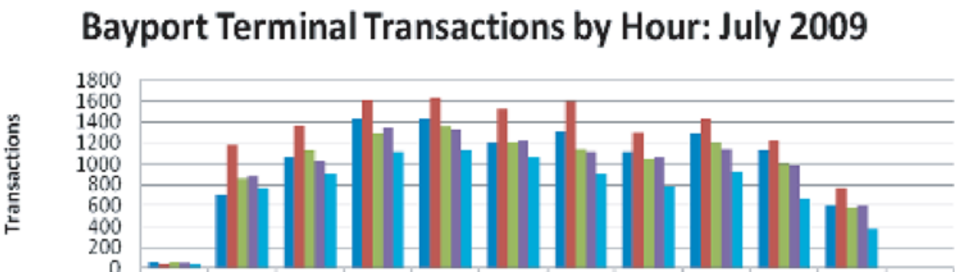


Figure 6–1. Day-of-week gate arrivals—sample terminal data.



	6AM	7AM	8AM	9AM	10AM	11AM	12AM	1PM	2PM	3PM	4PM	5PM
Monday	60	708	1074	1423	1427	1193	1307	1112	1285	1119	605	8
Tuesday	44	1172	1373	1608	1629	1514	1596	1293	1418	1225	765	4
Wednesday	69	859	1119	1281	1363	1209	1137	1052	1199	996	583	4
Thursday	53	872	1023	1343	1327	1222	1109	1061	1128	984	607	3
Friday	44	774	909	1116	1118	1058	907	777	923	666	377	0

Figure 6–2. Arrival patterns at Bayport, Port of Houston.

Cargo flows and transaction volumes at most marine terminals are inherently uneven. On vessel arrival days, a surge of import boxes passes from the vessel into the terminal. Import customers typically want their goods quickly, so there is a surge of drayage activity as well. Exports tend to arrive at the terminal during the week prior to vessel arrival, peaking before the outbound booking cutoff. Once the vessel is gone, activity declines.

Marine terminal gate hours vary, but most are roughly 8 A.M. to 5 P.M. Some terminals close the gates during lunch breaks, some keep them open. Customer hours also vary, but are commonly 8 to 5. Customers tend to prefer receiving imports in the morning and shipping exports in the afternoon.

Although marine terminal gate hours and container shipping and receiving hours may seem to align, in practice they often do not because of the time and distance between them. A drayage driver first in line at 7 A.M. can expect to leave the marine terminal with an export load by about 7:30 A.M. If the customer is 2 hours away, delivery will not be until 9:30 A.M. On the export side, a shipper 2 hours away must ship by 1:30 P.M. to be reasonably sure of getting the container in the gate by 4 P.M. For that shipper to receive at 8 A.M. and ship at 5 P.M., the marine terminal would have to be open from 5:30 A.M. to 7:30 P.M.

Since both drayage firms and their drivers are usually paid by the move, they have an incentive to make as many moves as possible. A driver who can start his first move at 8 A.M. by being in line at 7 A.M. has an opportunity to make more moves and earn more revenue than a driver who waits for the congestion to clear and starts his first move at 10 A.M. The second driver has a faster turn time on his first trip, but the first driver may earn more by making more trips in the day. Although many distribution centers (DCs) operate beyond the standard business day, most cargo is still shipped between 8 A.M. and 5 P.M.

Gate Queuing Solutions

The Gate Queuing Dilemma

For all the reasons above, gate queuing is difficult to reduce, much less eliminate.

In California, legislation forced San Pedro Bay terminals to adopt appointment systems and develop PierPASS (described later) to avoid being subject to massive fines for long queues. As of

2010, however, trade growth and cost-based reductions in gate hours have led to massive queues when San Pedro Bay terminals change from fee-based to free entry each evening at 6 P.M.

The uneven pace of truck arrival and existing labor rules presents terminal operators with a dilemma: to keep gates fluid and truck queues short, the terminal operators would have to hire substantially more labor than is actually required to handle the trucks. In an industry characterized by relentless cost pressure, the decision will often favor the terminal operator's budget at the expense of the drayage drivers.

Appointment Systems

Appointment systems are largely confined to Southern California at present. They have a mixed record there but hold the potential for wider application and are of interest to other ports and operators. Appointment systems have the following twin purpose:

- To allow drayage firms to make efficient dispatching plans with reduced driver queue times and
- To let marine terminals control workloads, thereby reducing drayage congestion and delay.

Several Southern California appointment systems were tried in response to threats of legislation over driver queue times. Some have fallen into disuse, but the remaining systems have been improved and refined. Maersk has subsequently adopted an appointment system at its new terminals in Virginia and Mobile, Alabama. That system, however, presently uses 4-hour appointment windows and serves primarily as a planning tool for the terminal operators. Because a driver can sometimes make multiple trips in a 4-hour window, there have been occasions when it was not clear which appointment the driver was keeping.

Most appointment systems have been designed with little input from drayage firms or drivers. There are a number of issues that have yet to be resolved in a uniform system, including the following:

- How available appointment windows will be allocated,
- How the gate will differentiate between drivers with and without appointments,
- How drivers without appointments will be handled,
- What obligations the terminal has to a driver who makes and keeps an appointment,
- What obligations a driver has to a terminal if he breaks an appointment, and
- Whether the appointment system will be used throughout the port.

The variability of over-the-road and urban transit times, discussed at length in Chapter 9, places a limit on the precision of appointment systems. At one extreme, 4-hour windows do not structure or regulate the flow of trucks. At the other extreme, 15-minute windows could not be maintained in ordinary operations due to the inherent variability of both drayage and terminal operations. The tight delivery windows characteristic of just-in-time replenishment systems are kept by letting trucks idle nearby until the delivery window opens, which would defeat the purpose in the marine terminal environment.

PierPASS

Southern California ports generate large volumes of truck traffic that contribute to congestion and emissions in the Los Angeles basin. To ease the burden of international cargo delivered locally on local highways and to further improve air quality, the PierPASS system was instituted. The goal of PierPASS has been to encourage the movement of containers in off-peak hours. Since July 2005, all marine terminals in the Ports of Los Angeles and Long Beach have offered OffPeak shifts on nights and weekends. A Traffic Mitigation Fee of $50 per 20-ft equivalent unit (TEU), or $100 per 40-ft container, is assessed on containers drayed through the ports during peak daytime hours, with certain exceptions. At present, between 35%–40% of all cargo moving through the ports is moving under the OffPeak Program. The traffic mitigation fee funds the extra labor for the OffPeak gate shifts.

PierPASS fees are implemented through RFID tags and alternative forms of driver and company identification. For drayage companies that routinely do business at the ports, the system functions smoothly, operating in the background and not causing exceptions at the gates. For occasional users, the system can cause delays and disputes.

Because PierPASS fees are not assessed after 6 P.M., drayage drivers wait outside terminal gates until that time. On busy days, this situation results in congested gates at, and shortly after, 6 P.M. The OffPeak fee is charged to the customer, not the trucker, so it is presumably the customer who has required the driver to queue up at 6 P.M. rather than enter the gate and pay the fee. Drayage firms and drivers are not ordinarily compensated more for waiting, so the driver has implicitly accepted a delay so the customer can save money. On the other hand, the PierPASS Program is predicated in part on the assumption that early morning and night hours will be less congested, so the driver may be accepting a gate queue delay but achieving a quicker overall turn time. By waiting in the queue at 6 P.M., he may be getting his work done earlier than if he waited until 7 P.M. or 8 P.M. when the queue had lessened.

Reduced business volumes during the current recession have created problems for the PierPASS/OffPeak system. Fees paid for daytime entry are used to offset the cost of keeping gates open for extended hours. At present (2010), however, off-peak fee collection has reportedly declined and cost-conscious terminal operators would like to avoid the added cost of extended gates. At the same time, problems with daytime congestion have abated, reducing the need for nighttime capacity. Terminal operators have reduced staffing for both day and night operations, and truckers are reporting longer turn times even in the era of reduced trade.

The longer turn times are particularly troublesome for truckers who have invested in new or retrofitted clean trucks, and who need enough daily turns to cover the truck payments. Most firms have structured their operations to take advantage of the nighttime hours, and now find those hours less productive.

The PierPASS/OffPeak system was designed to mitigate the effects of growing daytime congestion at the Ports of Los Angeles and Long Beach. Despite imperfections and teething problems it was largely successful and both truckers and customers adapted operations to suit. Under changing circumstances, the PierPASS/OffPeak Program will probably require more flexibility but the precise nature of that flexibility is not yet apparent.

Advanced Terminal Gate Designs

The most technically advanced gate observed by the NCFRP Project 14 study team was at APM Portsmouth, Virginia (Figure 6–3). The goal of the gate operation is to identify motor carriers with "clean" transactions early and process them quickly. There is an appointment system with a 4-hour window. Truckers tell the terminal when they are coming—mostly the day before. The trucks that have appointments equal 70%. Only 3% get trouble tickets. The average turn time is less than an hour.

Each truck coming to the terminal must be equipped with an RFID tag or it is not permitted to enter. The RFID readers are located on the Western Freeway interchange. As the trucks pass the reader, a computer is activated and the terminal prepares for the truck's arrival.

The first step in the process is a seal check, which is done for all trucks entering. This task is done by a clerk in a pickup before arriving at the first building. The data are entered into a handheld

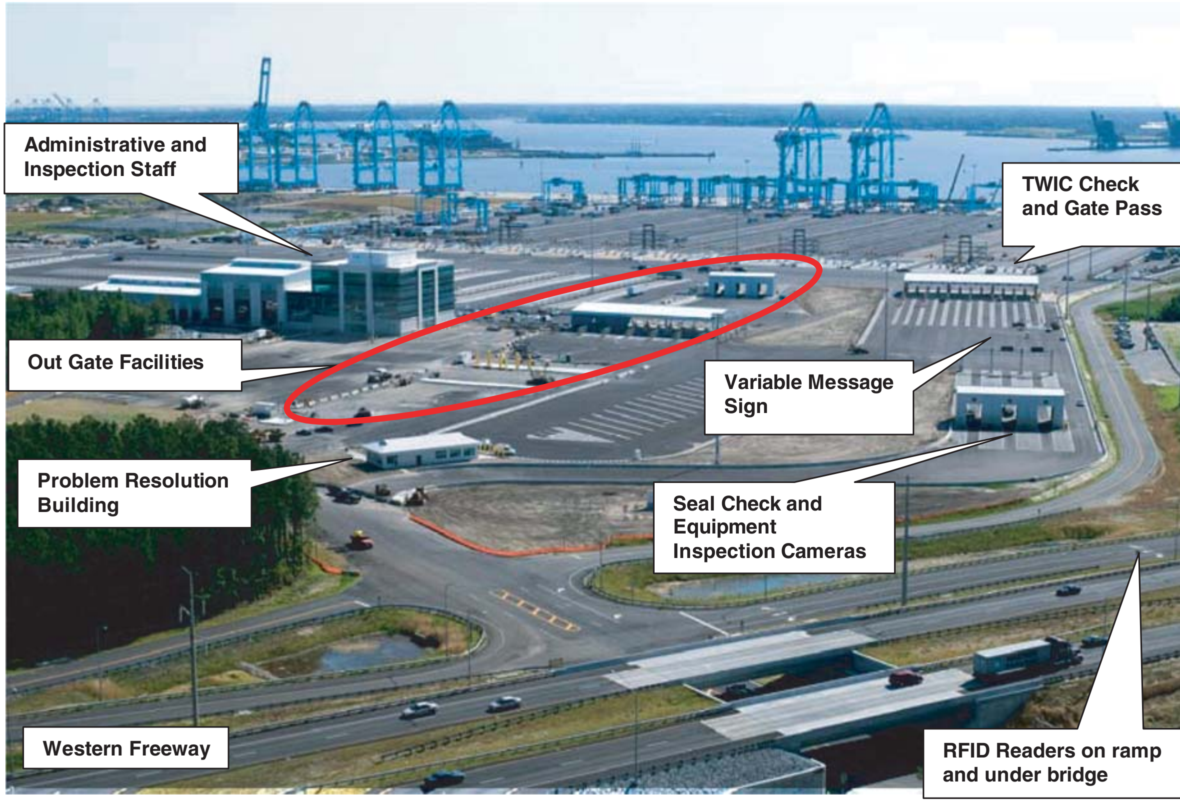


Figure 6–3. APM Portsmouth gate.

device, if necessary. The truck then proceeds to the first small building where a physical inspection is done by camera while the truck moves through. During the trucker's transition to the next station, an inspector located in the headquarters building reads the inspection photos. About a third of the way to the next building there is an overhead message sign that tells the trucker which of three sets of lanes he should use. (One set of lanes is for trucks with no problems, another set is for trucks without appointments and those with trouble tickets, and another returns rejected trucks to the beginning.)

At the second building, the driver swipes the TWIC. If the driver has an appointment and all is in order, the driver receives an entry permit and instructions. If the driver has an empty, the driver must get out and open the back door for an inspection by camera. This is a 2-minute process, on average.

If the driver does not have an appointment, a more conventional process is conducted in the lower part of the second building. It takes 6 minutes, on average, a very typical process time. If there is any kind of trouble, the driver deals with the problem at the trouble building—a small building located between the in/out gates. The parking area is the most visible aspect of Figure 6–3. At times a queue develops between the first and second inbound buildings.

The process is repeated at the out-gate with the radiation monitor being an additional step at the very end.

CHAPTER 7

Marine Terminal Gate Processing

Gate Capacity and Working Hours

Marine container terminal gate throughput capacity is a function of the number of gates available, the hours they are open, and the rate at which they process transactions.

Marine terminals may have up to 16 gates divided between inbound (in-gates) and outbound (out-gates). It is common for some of the gates to be reversible to accommodate either inbound or outbound transactions. The number of gates is generally proportional to the expected transaction volume. An older facility whose expansion has not kept pace with trade growth may have too few gates. A large, new terminal planned for long-term growth may have an overabundance at low start-up business volumes.

Marine terminal operators must decide how many gates to staff each day. Labor agreements may require additional clerks, supervisors, or relief workers to support the individual gate clerks. Generally, union labor must be hired for a full shift, which makes it difficult for terminal operators to vary gate capacity during the day.

Building and opening more gates seems the obvious way to reduce gate queues. As demand has increased, the number of entry gates has increased—both as entirely new terminals have been opened and as legacy facilities have been replaced. Remote adjunct chassis and container yards also have increased the number of gates available.

Opening a larger number of gates to reduce queuing, however, could simply shift the delays from the gate to an increasingly congested CY. Some terminal appointment systems serve to ration CY capacity, with the number of available hourly appointment slots set to the hourly CY throughput limit. When Southern California terminals were pressured to reduce truck waiting times outside the gates, some reportedly responded by speeding up gates or opening more gates to get trucks into the terminal faster without reducing the total turn time—the trucks simply waited inside the terminal instead of outside.

The use of OCR and video cameras for inspection has made it increasingly common for gate clerks to be located at computer terminals physically separated from the actual gates. Working in these remote locations also can allow a clerk to serve multiple gates.

The span of gate hours matters, specifically one-shift gate hours versus extended gate hours. Single-shift gates usually open at 7:30 or 8:00 A.M. and close at 4:30 or 5:00 P.M. in some combination. Extended hours can be earlier (e.g., opening at 6 A.M.), later (open until 6 P.M., or as late as 3 A.M. in some cases), or both.

Longer gate hours do not completely eliminate queues, since there will always be a queue before the gates open in the morning. Longer gate hours do, however, reduce the size of the morning queue, effectively spreading the morning "start up" period over several hours. Longer gate hours may not eliminate late afternoon queues either, because some of the late afternoon surge is caused by customers releasing containers late in the day. To the extent that late afternoon queuing is caused by truckers trying to complete one more transaction before closing, however, extending the gate hours should reduce that problem.

Closing for Meals and Breaks

Depending on local labor agreements and practices, gates may remain open during scheduled coffee breaks and meal periods or may close. Lunch breaks (and coffee breaks or shift-change breaks) that close gates cause major queuing problems and impose significant inefficiencies on the drayage industry. Gates can be kept open through breaks by staggering the break periods and using relief workers.

Trouble Tickets

The findings of NCFRP Project 14 point to exceptions from normal processes as a major source of delay and cost. The long “tails” on the turn time data, in particular, suggest that around 5% of the cases consume much more than the “normal” time and expense. “Trouble ticket” is the generic name given to exceptions in the port drayage process that are significant enough to be documented and handled separately. In most cases, a printed slip of paper—the trouble ticket—is issued to the driver, who then goes to an office or trouble window to have the issue resolved.

Trouble tickets are generated by exceptions that require interaction between some combination of driver, terminal staff, drayage firm, ocean carrier, and customer. Drivers have a strong incentive to complete the transaction as quickly as possible, so they will only bring an issue to the attention of the terminal staff if they cannot easily resolve it themselves.

About 5% of all transactions result in trouble tickets and each one adds about an hour to the turn time. That hour of a trucker’s time is worth $50 to $60. In 2007, the United States moved about 26 million containers through its ports. At 5%, trouble tickets are therefore affecting about 1.3 million annual movements and costing the industry roughly $65 million annually.

Minor exceptions that can be quickly resolved would not ordinarily generate a trouble ticket. Examples of minor exceptions could include the following:

- Missing information, such as a trucking company phone number, that a driver can quickly supply;
- Minor chassis defects that can be corrected at a roadability canopy; and
- A container on chassis that is not parked in the expected spot, but that the driver can quickly locate nearby.

“Turnaways” impact dray efficiency while sometimes not being fully internalized as a metric of terminal efficiency. When a truck at the Port of Houston is refused entry, for example, a trouble ticket is issued and a transaction is entered into the database. However, the “clock” that measures turn times never starts, thus it is difficult to know the true time cost penalty for the driver who is turned away. The difference in the mean turn times between troubles and non-troubles may thus understate the true impact of such problems. Truckers can be turned away at either gate stage for a variety of reasons. In the Port of Houston Webaccess System, most often turnaways will be designated in the truck visits database as a visit with no turn time, because the truck never completed its operation. The automatically generated explanations for abandoned visits rarely tell the full story but include the following:

- Shipper-owned empty container not returned,
- No empty pickup/load receipt,

- Shipping line rejects the load,
- Booking not correct for size/type/height of container delivered,
- Unknown booking number, and
- Trucking company not authorized for pickup by the ocean carrier (line).

When these trouble tickets are entered, there is no comprehensive way to show how or if the issue was eventually resolved. If the truck returns to the terminal later and is successful in entering, a new transaction number is generated. The severity of impact of turnaways on drayage is likely to be less severe for large companies. If there is an irresolvable issue with a container, a large company with a high volume of deliveries is more likely to have a backup job ready for the driver. Furthermore, if the turnaway issue is tied to a problem with the driver or the truck, a large company will tend to have an easier time finding another driver as a replacement.

Trouble tickets are usually documented in terminal information systems and given a code or phrase describing the reason for exception.

One important question is whether the trouble transactions are preventable. In principle, trouble transactions could result from the following:

- Unfamiliarity or lack of knowledge on the part of the driver, his firm, or the customer (particularly from those that serve the port irregularly);
- Carelessness on the part of driver, drayage firm, or customer;
- Information entry, transmission, or system errors; or
- Carelessness or error on the part of terminal gate or administrative clerks.

Figure 7–1 suggests that most trouble tickets could have been prevented through better pre-arrival communication.

One marine terminal provided the study team with a year's worth of detail on trouble ticket reason codes. Most of the trouble tickets issued can be categorized as booking, dispatch, or system problems (Table 7–1).

The one line of text that is the "reason code" typically deals only with the immediate symptom of a problem that could have several root causes. About 80% of those trouble tickets are process

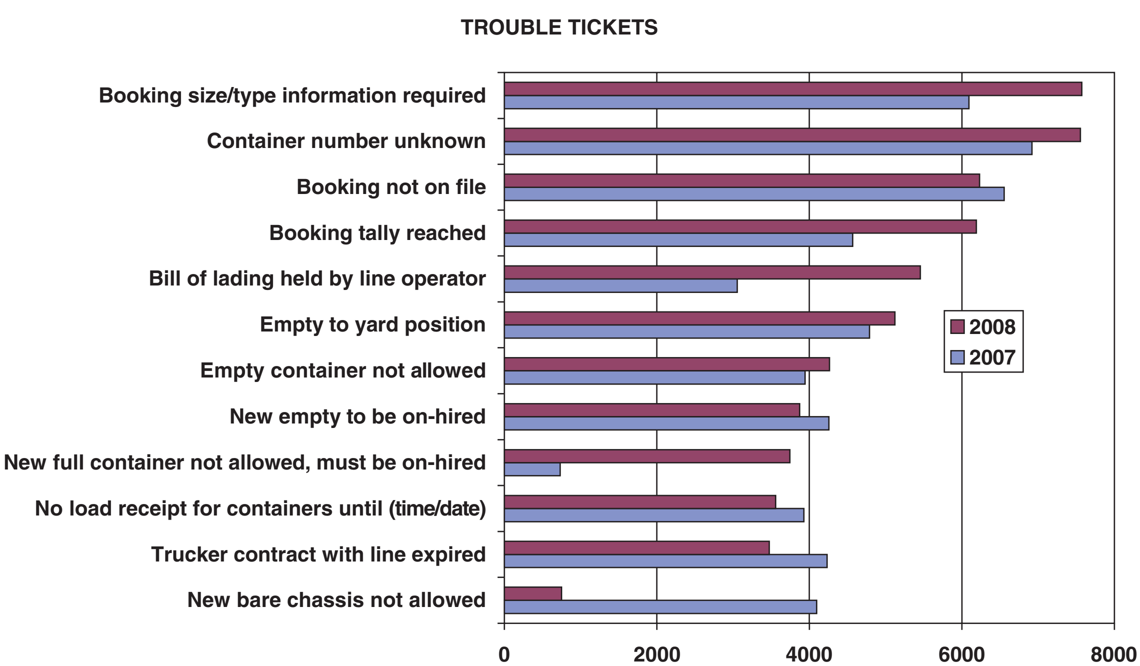


Figure 7–1. Sample data—leading causes of trouble tickets.

Table 7–1. Reasons for trouble tickets: data from one terminal.

Category	Reason	Share
Booking Problems		**28.4%**
	Booking does not match equipment type	9.5%
	Booking is not on file	6.5%
	Booking tally has already been reached	6.5%
	Missing notice for hazardous cargo	3.1%
	Booking quantity exceeded for equipment type	2.8%
Dispatch Problems		**29.2%**
	Cargo not yet released	8.4%
	Driver or motor carrier credential problem	6.8%
	Empty container/chassis not allowed	6.1%
	Past cargo cutoff	2.9%
	Demurrage due (unpaid bills)	2.6%
	Container exceeds maximum safe weight	2.4%
System Problems		**22.4%**
	Container/chassis not recognized*	17.9%
	Duplicate transaction	2.3%
	Container not found in yard	2.2%
Other		**20.0%**
Total		**100.0%**

* This category may also include tank, Hazmat, and other unusual loads

issues. Booking mistakes by the customer handicaps both the trucker and the terminal because it costs the terminal operator time and money to clear the problem. Analysis of the data leads to the following observations: A small share of the tickets did not represent an error of any kind. For example, one terminal creates a trouble ticket if a driver arrives before all of the container releases have been issued. This facility also serves a particular customer whose boxes are urgently required, and truckers purposefully dispatch drivers to the terminal in advance of the releases, thus guaranteeing a trouble ticket.

- About a third of the real trouble tickets are related in some way to lack of correct equipment-related information in the terminal's computer systems. The source of these issues varies from simple clerical data entry error to receiving equipment that the terminal's computer system does not recognize.
- Another third of the trouble tickets are related in some way to bookings. If the booking is not on file, incorrect in some way, or the dispatch does not match the booking, then trouble tickets are issued.
- The final third of trouble tickets relate in some way to the lack of correct information being available to motor carrier dispatchers. This manifests itself in a wide variety of "dispatch errors."

The most common trucking dispatch problems include the following:

- The terminal is not accepting return of the type of equipment presently in the custody of the driver. Empty return locations change frequently.
- The driver or drayage firm may not have the proper credentials available at the terminal.
- The container may be too early or too late for the outbound vessel cutoff.
- The container may be overloaded.
- The driver may be attempting to take the wrong box out of the terminal.

It is impossible to accurately assess responsibility for trouble tickets, except on a case-by-case basis. Failure of any of the parties in this complex logistics chain to communicate fully, effectively, and systematically via data interchange, voice, email, or text leads to mistakes by others in the system. Regardless of the cause, the drayage driver bears the consequence associated with the efficiency depleting trouble ticket process.

There is often an important distinction between proximate and underlying causes. At one terminal, for example, one of the major reasons for trouble tickets was that the number of export containers received exceeded the total on the export bill of lading ("booking tally reached"). On the surface, this situation would indicate either a paperwork error or an undocumented change of plans by the exporter. On further investigation, however, the research team learned that many such exceptions occurred when an export container arrived at the terminal and was entered into the terminal system, but was returned to the exporter for some reason (e.g., documentation error, defective cargo seal). When the export container left the terminal it was not deleted from the information system. When the same container returned, it was double-counted and generated the trouble ticket exception.

Driver Experience and Knowledge

Less experienced drivers and firms that do not regularly serve the port container terminals tend to generate exceptions and receive trouble tickets much more frequently than drivers and firms that are familiar with terminal systems and their requirements. The data presented in Table 7–1 and Figure 7–2 demonstrate the relationship between driver experience and the likelihood of delay due to a trouble ticket. The data are for an entire year and cover 14,199 drivers making almost 600,000 trips. Overall, 5.0% of the driver visits resulted in a trouble ticket. Those drivers making an average of at least one call per day had only a 3.0% trouble ticket rate. The rate rises dramatically for inexperienced drivers. Those making an average of at least one call per week averaged 4.4%; those making less than a weekly call averaged 7.8%.

There are several instances in which a less experienced driver may arrive at a port terminal. Trucking firms of all kinds typically experience high turnover of both employee drivers and owner subcontractors, so there are often new drivers coming into the pool. Trucking firms that usually handle the domestic business of a low-volume importer or exporter may make occasional trips to the port to maintain their relationship with the customer. Drivers handling seasonal products such as agricultural exports may make only a few trips to the port each year, and may never become fully familiar with terminal operations. Some trucking firms may ordinarily serve only one marine terminal due to their customers' ocean carrier preferences. Such firms and their drivers may find

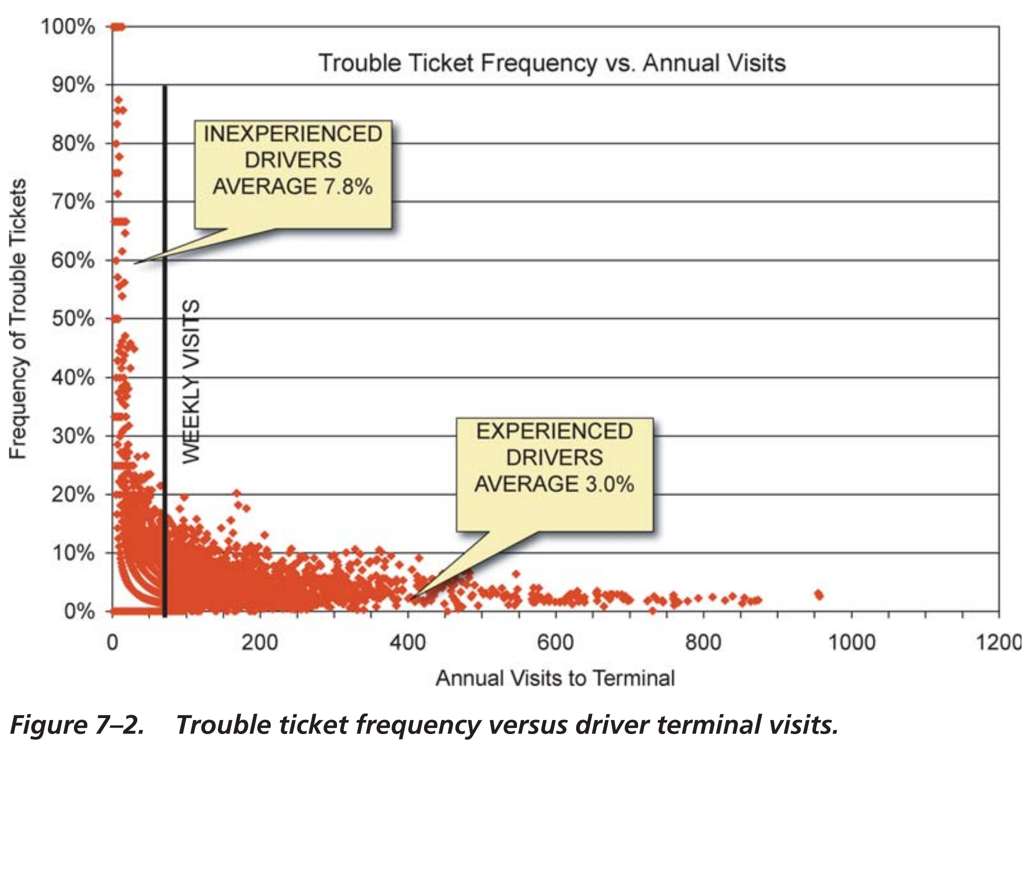


Figure 7–2. Trouble ticket frequency versus driver terminal visits.

Table 7–2. Variability in trucking company trouble ticket ratios.

Trucking Company	Total trips	Transactions per trip	% Trouble Tickets
A	1124	1.2	2.2%
B	2649	1.7	2.5%
C	1210	1.3	3.7%
D	1146	1.4	3.9%
E	2878	1.2	4.4%
F	1329	1.4	5.6%
G	1193	1.5	8.5%

themselves at an unfamiliar terminal if the customer changes lines, or if the chosen ocean carrier changes terminals. Pragmatically, a truck driver who only occasionally visits a marine terminal may not be able to justify spending the time and effort to learn the system, especially if the system might change by the time of his next visit. Moreover, a 30-minute delay at the port may not be significant to a driver delivering export cotton on an overnight trip from another state.

Drayage firms are not all equally committed to the same high level of professionalism found in the leading companies. Some customers and ocean carriers continue to purchase drayage service solely on the basis of cost, creating a niche for drayage operators who cut corners and leave drivers with the burden of delay. This niche is shrinking, as increasingly stringent safety, insurance, and environmental rules require increased professionalism and commitment. The best drayage firms do the following:

- Make good use of terminal and port information systems;
- Train and retain good drivers;
- Make more dual moves; and
- Work with customers, lines, and terminals, and have lower error rates.

As Table 7–2 shows for one case study terminal, there is also a wide variance in the frequency with which drivers from different companies receive trouble tickets. With an overall average of about 5%, there were clearly better-than-average performers and worse-than-average performers.

Some firms encounter frequent problems due to their business mix (hazmat, tanks, reefers). It is impossible from the data in Table 7–2 alone to determine whether Company G was careless or just had a lot of problem customers.

Ocean Carrier and Terminal Differences

Ocean carriers and terminal operators vary in the quality and consistency of their operations. Drayage companies report significant differences in working with different ocean carriers. Data from two lines at the same terminal can indeed show different trouble ticket rates. As shown in Table 7–3, Line A caused truckers more problems than Line B at the same terminal.

Gate Processing Solutions

Automated Gates: OCR and RFID

"Automated" gates that use OCR or RFID to identify incoming containers and match them with booking numbers, bills of lading, etc. can both reduce the minimum processing time and tighten the distribution by reducing errors or catching mismatched transactions more quickly. "Remote"

Table 7–3. Variability in ocean carrier trouble ticket ratios.

Transaction Type	Line	Transactions	Trouble Flag	% Trouble Tickets
Deliver Import	A	3,438	172	5.0%
	B	4,049	169	4.2%
Deliver Empty	A	3,869	307	7.9%
	B	10,106	485	4.8%
Receive Export	A	3,391	242	7.1%
	B	9,721	414	4.3%
Receive Empty	A	4,197	108	2.6%
	B	3,482	26	0.7%
Total	A	14,895	829	**5.6%**
	B	27,358	1,094	**4.0%**

gates that use video cameras to conduct visual inspections also can reduce processing time while increasing safety and reducing face-to-face friction between drivers and clerks. The process can be expedited further and errors reduced further where RFID, swipe cards, or a PIN entered on a keypad can identify the driver, the drayage company, or even the entire transaction.

Accurate and Complete Shipment Documentation

A significant number of trouble tickets are generated by shortcomings in import/export documentation or other transaction features beyond the driver's control. Examples could include the following:

- Dispatching an export container too early for a future voyage,
- Attempting to pickup an import container subject to unpaid fees or CBP inspection,
- Mismatched container and booking numbers, and
- Incomplete paperwork of any kind.

On arrival at the terminal, a driver attempting to complete such a transaction may be turned away, stalled at the gate, or issued a trouble ticket. Resolving the problem may require multiple phone calls between terminal, driver, and customer, and transmission of new documents or delivery of a check for unpaid fees.

Such delays are almost entirely avoidable. Other than a few inevitable clerical errors, these transaction shortfalls are a matter of diligence and care on the part of the customer. Here too, an inexperienced or infrequent importer or exporter may not know the process in sufficient or current detail, and may cause a disproportionate number of problems.

Taking Advantage of Terminal Information Systems

The data make it clear that many gate processing delays and trouble tickets are due to misinformation and miscommunication. Port and terminal information systems such as VoyagerTrack and eModal are designed to prevent such mistakes. These systems allow customers or truckers to verify that import containers are ready to be picked up, with all necessary payments and clearances complete. Although such systems are not immune to error, their consistent and proper use drastically reduces some transaction problems.

For export bookings, the information systems allow truckers to check booking information against the paperwork or electronic documents the customer has provided. Use of the available systems also will allow the trucks to check delivery windows for export containers on specific vessels and voyages.

Attn Trucking Community:

Please be advised that Rows 29 / 39 and 49 will not be open for truck delivery today on the 1st shift gate, due to vessel discharge from the NYK Atlas. There will be no cargo other then the NYK Atlas cargo that will start discharging into these area at 0800. These areas will be open for tonights Pierpass gate at 1800.

Please plan accordingly.

Thank you, YTI Management

(a) Example 1.

Vessels Working; Reliance

Stop-Work Meeting Thursday, Feb 4th, 2nd Shift

Areas Closed For Wheeled/Grounded Pickup: AG ,MRU-AG, MRU, VNV, NIC

Yrd Operation Advisory; There will be a MOD (must open door) Clerk on Broadway 1100 area for Drivers that want to inspect their mty contrs after receiving them.

Maersk Equipment Advisory:

Maersk Import containers, all type & sz, pulled from APM Term Pier 400 must be returned empty to APM Term Pier 400 (no chas split)

Maersk Import containers, dry sz 20' &, 40' Reefers, pulled from SSA Pier A on SSA/WCCP chas must be returned empty to SSA Pier A (no chas split).

Maersk Import containers, dry sizes 40', 40'hi &, 45' pulled from SSA Pier A on SSA/WCCP chas must be returned empty to

APM Term Pier 400 (chas split is required) until further notice.

Maersk Import containers, all type & sz, pulled from ITS Term Long Beach must be returned empty to ITS Term (no chas split).

Maersk Equip control contact is PSWDSPEQUPOS@MAERSK.COM -

EQU 310 221- 4904

(b) Example 2.

Figure 7–3. Messages from eModal.

These systems provide truckers with vital information regarding terminal operations, such as follows:

- Changes in gate hours, or in the availability of specific transaction types;
- Empty container or chassis shortages;
- Changes in the availability of import boxes or acceptance of export boxes for specific vessels and voyages;
- Instructions or restrictions on the return of empty containers; and
- Scheduled or unscheduled closures or system downtime.

Figure 7–3 provides examples of eModal messages.

Truckers who know and use these systems can adapt to changing conditions with varying degrees of success. Truckers who do not use these systems will experience a stream of unwelcome surprises, bottlenecks, and delays.

Training and Education

The performance difference between inexperienced and experienced drivers and firms implies a need for training and education.

- New and infrequent drivers need instruction on marine terminal protocol and processes including information exchange, CY operations, safety, and security.
- All firms and drivers need access to updated information on procedures and processes.

There are several options available to improve driver and drayage company information and training.

Terminal information systems and Web sites commonly include advisories aimed at drayage drivers. These advisories address safety issues, procedural requirements, and changes to operating hours or other day-to-day concerns. Expanding the scope of these advisories to cover documentation practices and reminders of common procedural or booking errors would open another channel of communication between terminal operators and customers.

Some ports publish trucker maps or brochures. Examples include the following:

- Port of Tacoma—www.portoftacoma.com/File.ashx?cid=2204
- Port of Baltimore—www.mpa.state.md.us/Links/Truckersmapforweb.pdf

Given the clear findings regarding trucker experience, there would appear to be a significant potential benefit to giving new or occasional truckers and their firms better access to information on terminal processes. The need for information may be particularly acute at ports such as NYNJ or LALB that have multiple terminals, emerging clean truck plans, and other unique aspects of their operations.

These information sources can be improved, updated, and coordinated or consolidated to create port-wide documentation. This is a challenging task, however, because the details of marine terminal processing, equipment management, security, and information exchange change frequently and on short notice. A second challenge is getting the information into the hands of drivers and firms unfamiliar with the port or its terminals.

Familiarization trips, where new drivers ride as passengers with experienced drivers, are a long-standing and effective practice. Recent security practices, however, have drastically curtailed the ability of new drivers, or anyone else, to enter marine terminals as passengers. There is an unmet need for port-wide security protocols to allow familiarization trips. The TWIC requirement can be made part of the protocol. Familiarization trips are also an effective way for port staff, customers, and other stakeholders to learn about the drayage and terminal system.

Some marine terminals offer periodic training classes for new drivers, others mandate such classes for drivers who violate safety rules. Generally, these training efforts are regarded as effective and valuable.

Choosing Drayage Firms and Ocean Carriers

Customers who choose a drayage firm solely on the basis of price or who ask non-port trucking firms to perform container drayage are doing themselves and other customers a disservice. As noted, choosing firms by price creates a niche for substandard drayage firms using inexperienced drivers and substandard equipment. Too often, such companies and their drivers do not invest the time and effort to learn and use port and terminal information systems or may even lack the technical capability to do so. Such firms may allow insurance certificates, interchange agreements, or tractor inspections and registrations to lapse, or fall behind in demurrage payments. All of these shortfalls in the trucking operation will trigger trouble tickets and other delays.

The TWIC requirement and the clean truck plans being put in place at various ports will restrict, or even prevent, an unprepared trucker from entering a port terminal. In many cases, the only option will be for the infrequent port visitor to turn the job over to a qualified port firm with a legal tractor and a TWIC-equipped driver. The study team has observed this process at NYNJ, where over-the-road carriers sometimes operate to and from the drayage company terminals, leaving the specialized drayage firm to perform the actual port trips. In Southern California, the increased need to use "clean" tractors for port trips has led to an increase in "dray offs"—the practice of using a clean truck to shuttle containers between the port and a nearby point where they are handed off to another tractor for delivery inland. The potential imposition of container fees at some or all ports will complicate matters further for unprepared truckers. An experienced trucker arriving at a Southern California container terminal during the day shift, for example, will be subject to the Off-Peak fee payable by the beneficial cargo owner (BCO). The inexperienced trucker is unlikely to have an OffPeak account, the expected RFID equipment, or any means to quickly resolve the problem.

The need to choose a qualified drayage firm poses a classic dilemma: customers who do not understand the complexities of the port process are unlikely to appreciate the value of an experienced drayage partner, especially for infrequent shipments.

Choosing an Ocean Carrier

Although the research team did not make distinctions between named carriers or terminals, it is clear that there are notable differences between them when it comes to drayage productivity. The differences appear to be traceable to the following:

- Investment in, and sophistication of, carrier and terminal information and operating systems;
- Staffing levels and staff experience; and
- Adequacy and performance of terminal equipment and facilities.

As in choosing a drayage firm, customers that choose an ocean carrier solely on the basis of carriage rates may find themselves incurring delays, unreliability, and higher drayage costs as a result. Experienced drayage firms and drivers are reluctant to serve ocean carriers and terminals with bad reputations, and may justifiably postpone trips in hopes of avoiding problems, or quote higher rates.

A recent study of port productivity on behalf of the Cargo Handling Cooperative Program (CHCP) included a survey of customer attitudes toward marine container terminal productivity. That survey found that 68% of the respondents considered drayage turn time to be very important in evaluating container terminal productivity, 74% considered reliability (% on schedule) to be very important in evaluating container terminal productivity, and 63% would consider splitting import or export volume between ocean carriers at the same port based on container terminal efficiency/productivity.

Managing Non-Standard Transactions

Most of the drayage transactions considered in this project and handled at marine container terminals involve dry van containers and loads without special characteristics. Containerized loads with special characteristics include the following:

- Hazardous materials (hazmat),
- Refrigerated containers and commodities,
- Liquid in tank containers,
- Open top or flat-rack containers,
- Overweight loads, and
- Oversize ("out of gauge") loads.

Such loads all require some degree of special handling and processing and, in many terminals, these loads automatically generate trouble tickets. Customers and drayage firms that regularly handle such loads know the process and plan accordingly. Firms that only occasionally handle such loads may experience long delays.

Customers who mix standard and non-standard container loads on the same bill of lading risk having the standard loads delayed if hazmat or other loads trigger trouble tickets for all customers on the same bill. This problem and others are symptomatic of limitations or quirks in terminal information systems. Although the ultimate solution is to correct the systems problems, the near-term solution is for customers and drayage firms to adjust business practices to current realities.

Information and Communication

Information and communication errors are the dominant cause of exceptions and trouble tickets. That finding is clear from both quantitative terminal data and qualitative driver and drayage company survey results.

In principle, almost all information and communication errors should be preventable. As the research findings show, the frequency of trouble tickets declines with driver experience. From the driver and drayage company surveys, it is clear that experienced drivers and dispatchers place great importance on pre-dispatch verification of container status, etc.

A significant portion of the trouble tickets and exceptions is apparently traceable to shortcomings or quirks of the marine terminal operating systems. Examples include the following:

- Drivers who are stopped at exit gates because they have been given, or allowed to choose, an empty container that was reserved in the system for another use;
- Inbound drivers that are stopped because the container they are carrying is still in the system from an earlier unsuccessful transaction;
- Drivers who are turned away with empty containers because the return instructions have changed since the container was picked up; and
- Drivers who are stopped because the equipment they are carrying is not listed in the terminal operating system.

The timing of information is also a factor. Drayage company dispatchers commonly create a morning dispatch plan and communicate it to the drivers the previous night. This practice enables the drivers to position themselves and begin work as early as possible. If the terminal's empty return instructions are changed late at night or early in the morning, however, the dispatch plan may be out of sync and may result in trouble tickets and exceptions.

Gate Bypass and PINs

The logical extension of the two-stage gate approach may be exemplified by the recently retrofitted system at Houston's Barbours Cut where the first gate stage is 1.5 miles away from the second stage and has its own parking area for drivers with problems to stop and contact their dispatchers. Once clear of the first gate, the drivers are issued a personal identification number (PIN) to be used at the second gate. Trucking firms have the option to complete the first stage of the process on-line and give their drivers a PIN in advance, enabling the drivers to bypass the first gate.

CHAPTER 8

Container Chassis Supply Time and Delays

Chassis Logistics

Chassis logistics are a uniquely prominent issue at U.S. ports for two reasons. First, chassis are far more complex and subject to damage than containers, are subject to highway safety requirements, and account for the great majority of equipment-related delays and problems. Second, in the United States, chassis are normally provided by the ocean carriers and usually stored and maintained on the marine terminal.

As of 2007, there were roughly 650,000 international chassis in the United States (and about 160,000 domestic chassis). About 90% of the international chassis were provided by individual ocean carriers or alliances, with the rest provided by others (neutral or cooperative pools or motor carriers).

The chassis is usually owned by the ocean carrier and interchanged with the container, so chassis ownership must ordinarily match container ownership. An APL container must be on an APL chassis, a Maersk container on a Maersk chassis, etc. A drayage firm with permission to pick up a container from one carrier would not have permission to use another carrier's chassis to do so, despite complete physical interchangeability.

The cost, delay, productivity, and capacity penalties associated with container logistics are largely avoidable. Provision of container chassis by ocean carriers at the marine terminals is a legacy of containerization's origins in the United States The original Sea-Land System, as envisioned and implemented by Malcolm McLean, functioned as a trucking company with a waterborne line-haul. As such, Sea-Land provided the chassis to let the marine containers operate as truck trailers. This practice set the pattern for other U.S. operators and has persisted in the United States, where the land area in terminals permits either wheeled storage or the maintenance of on-site chassis fleets.

Everywhere else in the world container chassis are supplied by customers, truckers, or off-terminal pools, and are brought to the marine terminal by the drayage driver. Drivers in other countries do not interchange chassis with the ocean carriers or terminal operators. Costs or delays in obtaining a chassis are therefore an internal drayage company issue in those countries, and of no concern to the marine terminals (as long, obviously, as the chassis is functional).

Container chassis logistics can become a drayage bottleneck in several of the following ways where drayage drivers:

- Incur delays in locating and attaching a serviceable chassis in grounded marine terminals,
- Incur delays in repairing or swapping unserviceable or mismatched chassis in wheeled marine terminals,
- Are delayed by chassis condition issues at inbound or outbound gates, and
- Are required to make extra trips to obtain or drop a chassis at a second location (a "split delivery").

On-Terminal Chassis Supply

Once in the container yard there are three principal ways for a drayage driver to locate and hook up to a container or chassis.

1. By locating a container already mounted on a chassis at a wheeled terminal.
2. By locating a bare chassis and taking it to a container stack where a lift machine will mount the container in a stacked terminal.
3. By locating a bare chassis and taking it to a designated zone where a lift machine will bring and mount the container in a transfer zone terminal.

The driver must first locate the correct unit. Containers on chassis are identified by an alphanumeric combination indicating ownership and number, such as APLU 123456. "APL" indicates American President Lines, "U" indicates a container, and "123456" is the number of the specific unit. Most containers also have a distinctive color and logo. Bare chassis also are identified by an alphanumeric combination such as APLZ 245789, where "APL" again indicates "American President Lines," "Z" indicates a chassis, and "245789" is the specific unit number. Chassis may or may not be painted and lettered distinctively.

If the container is not already mounted, as in a wheeled operation, the driver must choose a chassis that matches the container in length (20-ft, 40-ft, 45-ft, or "extendable") and ownership. In many cases, the chassis must be owned or controlled by the same ocean carrier that owns or controls the container. Where there are vessel-sharing agreements or terminal chassis pools, other rules may apply. With a "neutral" chassis pool, any chassis of the correct length may be used with any container.

Special containers may have special chassis requirements. For a refrigerated container, the chassis must be mounted with a "genset," a motor/generator combination to supply electric power to the refrigeration equipment. Overweight containers and tank containers may require special 3-axle or drop-frame chassis, often supplied by the drayage firm.

Chassis Equipment Issues

Once the driver has located the mounted container or a suitable chassis, the driver must check the condition of the chassis. An over-the-road container chassis (Figure 8–1) is a far more complex piece of equipment than a container, and includes multiple systems that must all function correctly to be serviceable.

- Landing gear—The chassis landing gear must be intact, straight, and crank up and down easily. Landing gear can be bent or jammed and the "sand shoes" at the bottom are sometimes missing.

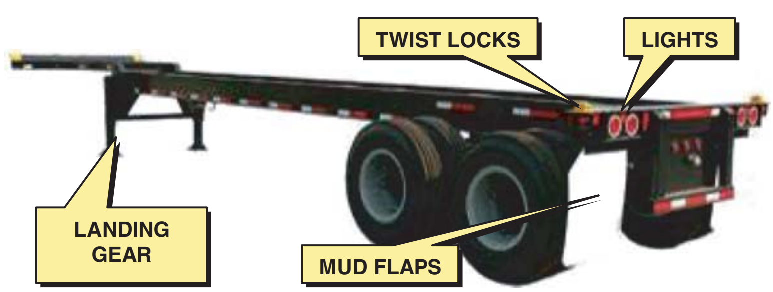


Figure 8–1. Over-the-road container chassis.

- Twist locks—The four twist locks that secure the corners of the container to the chassis must be operable. These are fairly robust assemblies, but are sometimes damaged or jammed.
- Tires—A 40-ft chassis usually has eight tires, all of which must have adequate tread depth and inflation. The typical practice is to thump the tires with a heavy metal bar for a rough check.
- Mud flaps—The mud flaps must be present and in good enough condition that the driver will not be cited on the road.
- Brakes—Chassis air brakes must apply and release properly once hooked to the tractor. Some drivers carry simple tools to adjust brake shoes on the spot.
- Lights—Lights and lenses must be intact and operate correctly. Lenses are typically set into the rear bumper for protection, but are still vulnerable to damage. The connectors to the trailer must also be in good condition—damage or corrosion from the salt environment can be a problem.
- License, registration, and inspection tags—For road service, the chassis license and registration sticker must be current, and any required inspection stickers up to date.
- Structure—The chassis must be structurally sound, without damage, twisting, or "racking" (horizontal misalignment). In addition to the possible effects of age and traffic accidents, chassis can be structurally damaged when stacked or stored in the terminals (Figure 8–2).

The operating environment for container chassis is inherently difficult. The container loading process is often rough. Chassis are often parked in rough ground and stacked for storage in slow periods. At some terminals, they are stored vertically in racks. At customer locations, they are pushed up against loading dock bumpers. In rail intermodal terminals, they often are crowded into makeshift parking areas. Sideswipe and corner collisions are common in all of these facilities. Chassis condition is critical from the following three perspectives:

1. **Safety and liability.** Drayage firms and their drivers are acutely aware of safety risks and potential liabilities connected with chassis condition. Firms and drivers that perform short transfers in the port area may be less careful, but established professional firms that dray containers over public roads through urban areas have little tolerance for unsafe equipment.
2. **Damage disputes.** The chassis and the container it carries are interchanged to the drayage firm and the firm becomes liable for any damage beyond ordinary wear and tear. The chassis will be inspected when it is returned to the marine terminal, and the drayage company can be billed for any necessary repairs. The cost of even a minor repair, such as a broken light lens, can easily exceed the company's profit on the move. Moreover, the administrative burden of dealing with damage claims and repair bills can exceed the amount of the bills themselves.

Figure 8–2. Stacked chassis.

3. **Highway citations.** Drayage operations are subject to the same highway laws as other truck movements, and complaints about the condition of drayage equipment often lead local police or highway patrol officers to pay special attention to trucks entering or leaving the port. Citations for defective equipment are costly. The laws affect the operation of defective or unsafe equipment, not the ownership, so it is the driver who is cited.

If the chassis passes all of these checks, the driver is ready to either leave with the mounted container or take the chassis to have a container transferred from the stacks.

If the chassis has a minor problem such as low tire pressure, a broken tail light lens, or a missing mud flap, the driver usually has the option to take the chassis to a roadability canopy or similar facility, to be fixed on the way out. In well-run terminals drivers generally choose this option rather than searching for another chassis because it takes less time (i.e., a few minutes).

When the chassis has a more serious problem, such as structural damage or non-functional landing gear, most drivers will search for another chassis rather than waiting to have the first one fixed. If the container is already mounted on an incorrect or defective chassis, the driver must choose between (1) waiting to have it fixed, (2) waiting for a chassis "flip," or (3) choosing another unit. In the workshops, the study team learned that the driver will typically spend around 30 minutes trying to resolve such a problem before switching to another transaction.

Serious delays can occur when there is no suitable chassis in good condition immediately available. Chassis parking takes up valuable terminal space, so many terminals stack extra chassis or store them vertically in racks. Drivers sometimes find that the suitable chassis in good condition are thus inaccessible. The terminal operator may prefer to have the driver wait while an available chassis is fixed rather than dispatch terminal employees and equipment to retrieve another chassis from the stack or rack (and ocean carrier equipment policies may enforce this preference). Drivers also sometimes report having to move one or more chassis on the ground to gain access to a good one.

A clear inefficiency, one that is common to most terminals, is that once a driver has inspected a chassis and found it defective, he does not mark it or identify it in any way so that future drivers do not engage in the same futile process. Thus, there is a possibility that the same bad chassis can cause a series of delays for multiple truckers before it is repaired or removed. Ultimately, the decision as to whether a chassis is rejected or accepted is entirely dependent on the judgment of the driver. Furthermore, the same driver will accept or reject a specific chassis dependent on the situation. For example, if no additional chassis remain that are roadworthy, the driver will select a non-roadworthy chassis and have it repaired prior to leaving the terminal.

Chassis Flips

Containers are mounted before the driver's arrival in a wheeled operation. If the container has been mounted on the correct chassis, there is no delay. In exceptional cases where the container has been mounted on the wrong chassis due to error or expediency, the container must be transferred to a correct chassis before the driver can take it out of the terminal.

A chassis "flip" of this kind can easily result in a delay of an hour or more. The incorrect chassis with the container, a correct bare chassis, and a lift machine must all be brought together for the transfer. Although it may not be the drayage driver's obligation to do so, the fastest way to accomplish this is often for the driver to find a correct chassis and pull it to the loaded one. The transfer is commonly made by a mobile lift machine. Chassis flips of this kind are also one of the few significant bottlenecks at rail intermodal terminals.

Chassis Supply Solutions

FMCSA Chassis Roadability Rules

New chassis roadability rules promulgated by FMCSA[1] took effect in 2010. The Final Rule on Chassis Roadability was published by FMCSA in December 2008. In summary, it calls for the following:

- Identification of a single Intermodal Equipment Provider (IEP) for each chassis (by December 2009),
- IEP establishment of inspection, maintenance, repair, and recordkeeping programs (by December 2009),
- A standardized audit trail of driver Roadability Component Defect (RCD) reports, Driver Vehicle Inspection Reports (DVIR) and repair records, and
- USDOT number applied to all chassis (by December 2010).

The key effect is to hold IEPs responsible for maintaining chassis to FMCSA standards, and to establish a corresponding audit trail. Ordinarily, there is no law against owning a defective or substandard chassis, but there *are* laws against operating unsafe equipment on public roads. The burden has thus previously been placed disproportionately on the drivers and motor carriers, who must either find a good chassis or wait to have one fixed. Too often, this situation led to drivers using substandard chassis rather than incurring the economic loss from delay.

The standardized audit trail will help ensure that IEPs actually maintain chassis on schedule and repair defects noted by drivers. Drayage firms and drivers all have stories about defective equipment that was put back in service without repairs, defective chassis that clogged terminal parking areas for long periods, and drivers that were charged for preexisting damage.

The primary impacts on port drayage should be as follows:

- Reduced frequency of trouble tickets and delays related to chassis defects; and
- Reduced chassis search time due to fewer, better chassis at the terminal.

These results coincide with some of the chassis pool benefits. These benefits are not automatic; realizing them may require significant enforcement activity by FMCSA. The final rule provides for periodic “roadability reviews” by FMCSA with the possibility of civil penalties or removal of equipment from service for violations.

The new roadability rules may create incentives for terminals to devise and implement a process for drivers to tag substandard chassis and for maintenance personnel to fix them. Under current practice, substandard chassis may sit in the parking area indefinitely, causing congestion and delay. Ocean carriers are usually reluctant to authorize repairs as long as records show there to be chassis on hand. The current de facto process is that a chassis is fixed only when a drayage driver decides it is the best one available and pulls it to a roadability canopy or other maintenance site.

Near-Term Solutions: Neutral Chassis Pools

Neutral chassis pools are an obvious near-term means of reducing chassis-related CY bottlenecks. The practice of chassis pooling is spreading at inland rail terminals as well as at marine container terminals. As described above, these are multiple pooling approaches. From the drayage perspective, the various options are all effective if they

- Improve the quality of chassis, reducing the need to search for a good unit or to have a sub-par unit fixed;

[1] 49 CFR Parts 385, 386, 390, et al., December 17, 2008.

- Eliminate the need for chassis flips due to mismatched container and chassis; and
- Reduce the need to reposition empty chassis.

An EPA SmartWay publication[2] notes the following:

> Common chassis pools can provide a more efficient management of terminal assets, increase the volume of goods through the port, and free-up space used to store chassis on port lands. Additional fuel savings from reducing miles traveled while switching chassis is dependent on the size of the port facility and its physical layout. Pooled chassis can also facilitate the implementation of virtual container yards (VCY) and empty container yards (ECY), reducing the number of empty container movements, congestion and wait times at terminal gates.

Terminal Pools

Terminal pools are often maintained at terminals operated by independent stevedores (such as SSA) that have multiple client ocean carriers. Where the terminal pool is the only chassis source, it effectively becomes a neutral chassis pool. Where a terminal pool just supplements carrier chassis supply at the same terminal, it would not have the same advantages as a neutral pool.

Cooperative Pools

The cooperative chassis pooling concept was pioneered by Maher Terminals at the Port of New York and New Jersey. The multiple lines calling at Maher's Terminal contributed chassis to the pool, initially in proportion to their container volumes. The pool was able to achieve a 25% reduction in the number of chassis required to serve the combined volume. Chassis condition also was improved.

Consolidated Chassis Management (CCM) pools currently include over 100,000 chassis at pools serving the South Atlanta and Gulf port areas as well as inland points such as Chicago, the Ohio Valley, Denver, and Atlanta. CCM is an affiliate of the Ocean Carrier Equipment Management Association (OCEMA), and was established in 2005 to develop, own, and operate chassis pools. The CCM pools are assembled from chassis contributed by the 20 ocean carrier members and pool participants and leased from independent fleets such as Flex-Van and TracLease. All CCM pool chassis must meet FMCSA standards. The unitary Pool Concept implemented by CCM creates a single pool at each facility, allowing leasing companies with neutral pools in place to become contributing users in the CCM pool. Folding in the neutral pools also accommodates ocean carriers that are not CCM members. Actual operational management of CCM pools is performed by either Flex-Van Leasing Co. or Seacastle Chassis/Trac Lease, depending on location.

Third-Party Pools

A good example of a third-party pool is the TRAC Metro Pool-Metz regional chassis program. The pool currently charges $9 per day and is accepted at eight marine terminals located in Baltimore, Philadelphia, Staten Island, and Northern New Jersey as well as six rail intermodal terminals. The pool contains more than 14,000 chassis and serves 17 marine shipping lines. Typically, the lines pay the chassis charges. The advantage for the motor carrier is that it can make double moves as long as the service involves participating lines, railroads, and/or marine terminals. TRAC is responsible for normal wear and tear. The motor carrier pays only for damage. TRAC is responsible for keeping the pool equipment in balance. Repositioning costs are charged to members responsible for deficit situations.

Direct ChassisLink

APM/Maersk is in the process of changing the way in which the firm supplies chassis. The Maersk Equipment Service Company, Inc. (doing business as Direct ChassisLink Inc.) is now

[2]*A Glance at Clean Freight Strategies: Common Chassis Pools for Drayage,* U.S. EPA Office of Transportation & Air Quality, Washington, D.C., undated.

providing Maersk fleet chassis to motor carriers for $11/day. The effort began in the Port of New York and Northern New Jersey rail terminals and container yards in late 2009. The system now involves 16,000 chassis, 25 locations, and 10 states.

The structure of this pool permits Maersk to operate efficiently in a wheeled environment as the motor carriers can conveniently off-hire chassis in several locations. In addition, Maersk provides a discount when chassis use is tied to free time Maersk provides to its customers.

Long-Term Solutions: Trucker/Third-Party Chassis Supply

Chassis condition and supply is a perpetual point of contention between drayage firms, marine terminal operators, and ocean carriers. Chassis are a source of trouble for all concerned as follows:

- Ocean carriers incur the expense of providing, maintaining, and managing chassis only in the United States. Chassis supply is a management headache and a cost center to be minimized whenever possible. Given a choice, ocean carriers would probably exit the chassis business.
- At marine terminals, chassis supply uses up valuable space, ties up lift equipment, and requires far more maintenance equipment and labor than containers. Given a choice, terminal operators would probably also exit the chassis supply business and move the function off-terminal. Some terminals have already moved chassis functions off-terminal whenever possible.
- Drayage firms and their drivers begrudge the time spent locating chassis, the time spent dealing with chassis condition, the need for chassis flips, extra trips to reposition chassis, and administrative time and cost for resolving damage and liability issues. Given a choice, many drayage firms would prefer to provide chassis themselves (with appropriate compensation), or have chassis provided by customers or third parties.

A potential long-term strategy would be for ocean carriers to stop providing chassis and shift to the systems used in other countries. That shift also would bring port drayage in line with other trucking sectors, all of whom typically supply their own trailers. Changing to a trucker, customer, or third-party chassis supply would eliminate

- The need to identify or inspect chassis at marine terminal gates, or to document their interchange (EIRs would still be needed for the containers themselves);
- The need for drivers to locate a chassis at grounded terminals, or to spend time hooking up to chassis and testing chassis condition;
- All trouble tickets, disputes, and other exceptions related to chassis (although equipment-related trouble tickets are a small portion of the total);
- The need for chassis flips for mismatched chassis and container combinations;
- Roadability canopies and chassis maintenance and repair (M & R) functions at marine terminals; and
- The need to store chassis at marine terminals, thereby freeing up substantial space.

It is likely that elimination of carrier-supplied chassis also would relieve marine terminals of the need to supply generator sets for refrigerated containers.

Such a change would likely also eliminate wheeled operations at marine terminals, which is itself a logical evolutionary step for the industry. A shift to trucker, shipper, or third-party chassis supply would also affect the operation of rail intermodal terminals, which are almost all wheeled.

CHAPTER 9

Marine Terminal Container Yard Congestion

Container Yard Congestion Impacts

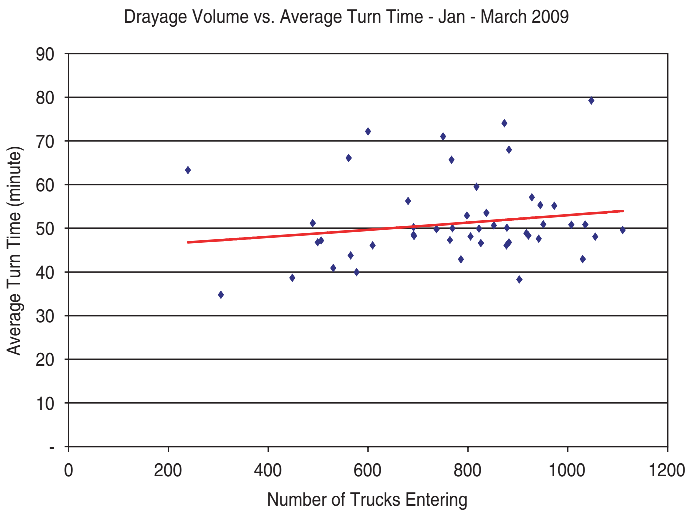
The impact of congestion at marine terminals can be seen in the relationship between volume and turn times in Figure 9–1. Although the general relationship is clear, the specifics will vary by terminal. In the examples, the first terminal is relatively unaffected by volumes of up to 1,100 per day while the second shows marked increases in turn times for volumes above that level.

Congestion also results from disruptions to marine terminal operations. Such disruptions have resulted from work stoppages, labor shortages, changes in ocean carrier calls, and rail service shortfalls. A short-lived event such as a systems problem will lead to congestion while the terminal gets back to normal. More extended problems such as changes to vessel, carrier, or alliance terminal assignments may result in congestion for weeks or months as the terminal, the customers, and the drayage firms adapt.

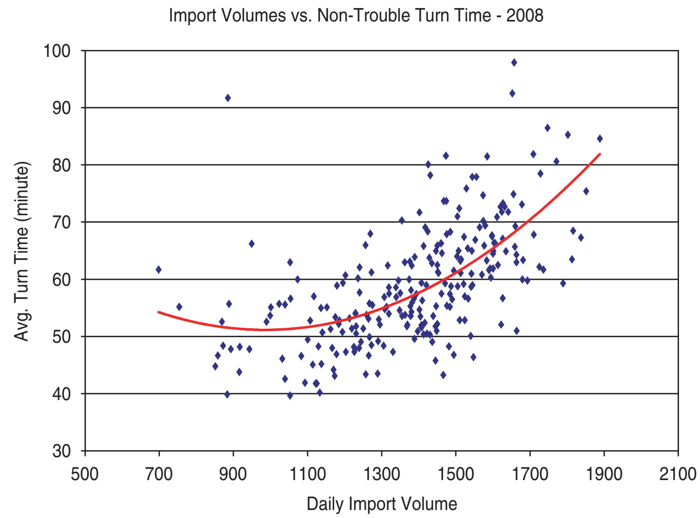
Errors or disruptions within the CY are generally not documented in terminal operating systems, seldom result in trouble tickets, and most incidents by themselves are not serious, yet can be a major source of cumulative delay. The research team learned of a wide variety of potential problems, including the following:

- Drivers and tractors getting out of order in lines waiting to receive containers in the stacks,
- Lift equipment malfunctions,
- Errors in communication between the gantry crane operator and driver,
- Drivers pulling the wrong container in wheeled terminals,
- Lift equipment transferring the wrong container in stacked terminals,
- High wind conditions that can slow or interfere with lift equipment operations,
- Inexperienced drivers going to the wrong pickup point or being unaware of procedures,
- Retrieving containers that require excessive rehandling due to their position in the stack,
- Labor shift changes,
- Redirection of assets from yard operations to ship operations,
- Traffic jams that can occur because too many trucks are in the terminal at a given time, and
- Specific lane blockages from trucks queuing behind a specific crane.

All of these delays are considered a normal part of terminal operations and are not typically seen as the first areas that require specific intervention. Nevertheless, terminals do have some ability to reduce the probability of routine CY delays. For example, ports can institute driver education efforts that include a notification system for changes in terminal procedure. Better coordination between gate operators and lift operators can ensure that the CY does not become excessively crowded. Furthermore, solid redundancy procedures to handle excessive demand for a particular gantry crane can help to prevent localized gridlock from occurring within the terminal.



(a) Example 1.



(b) Example 2.

Figure 9–1. Congestion impacts.

Marine Terminal Disruptions

Brief or extended disruptions to routine marine terminal operations will create drayage bottlenecks and impose delays. The bottlenecks and delays can result from the following:

- An interruption in terminal functions, followed by congestion while the backlog of postponed transactions is cleared;
- A short-term diversion of terminal resources (equipment or staffing) to other functions, leaving drayage-related functions under-equipped or under-staffed and therefore slower;
- A change in terminal operations or processing that creates short-term confusion and inefficiency; and
- An increased workload for which the terminal was not sufficiently prepared, such as a trade surge, military deployment, or ocean carrier terminal shift.

Longer disruptions result from persistent congestion, major terminal changes, or start-ups at new terminals.

Short-Term Interruptions

A marine container terminal is a complex enterprise reliant on infrastructure, equipment, systems, and labor working together. Cost-conscious planners and managers keep redundancy and excess capacity to a minimum. Moreover, the primary goal of the terminal's direct customer, and thus the primary goal of the terminal itself, is to turn the vessel on schedule. If equipment or labor are in short supply, the vessel will be served first and drayage-related functions later.

Marine terminals usually have some margin of excess capacity in mobile lift equipment such as RTGs, straddle carriers, and sideloaders. The loss of one or more pieces of equipment due to damage or failure will, however, slow drayage operations, especially in busy periods. Field work and observations indicate that it is common, although not universal practice to assign the oldest, slowest, and least reliable mobile equipment to serve drayage trucks, reserving the best equipment to support vessel operations.

Information systems technology is far more reliable than it was a decade or more ago but "the computer is down" is still a familiar and frustrating refrain. The intricate flow of documentation required to support terminal and drayage operations comes to a stop when the information system is unavailable for any reason. The near-complete reliance of the industry on computers and other electronic systems means that full manual operation is no longer a reasonable possibility. Some subsystems, such as gate RFID or OCR systems, can be bypassed if necessary. A shutdown of the terminal operating system, however, will bring all operations to a halt. Many of the worst terminal queuing problems are due to some variation of "the system is down" that affects all gates and all drivers.

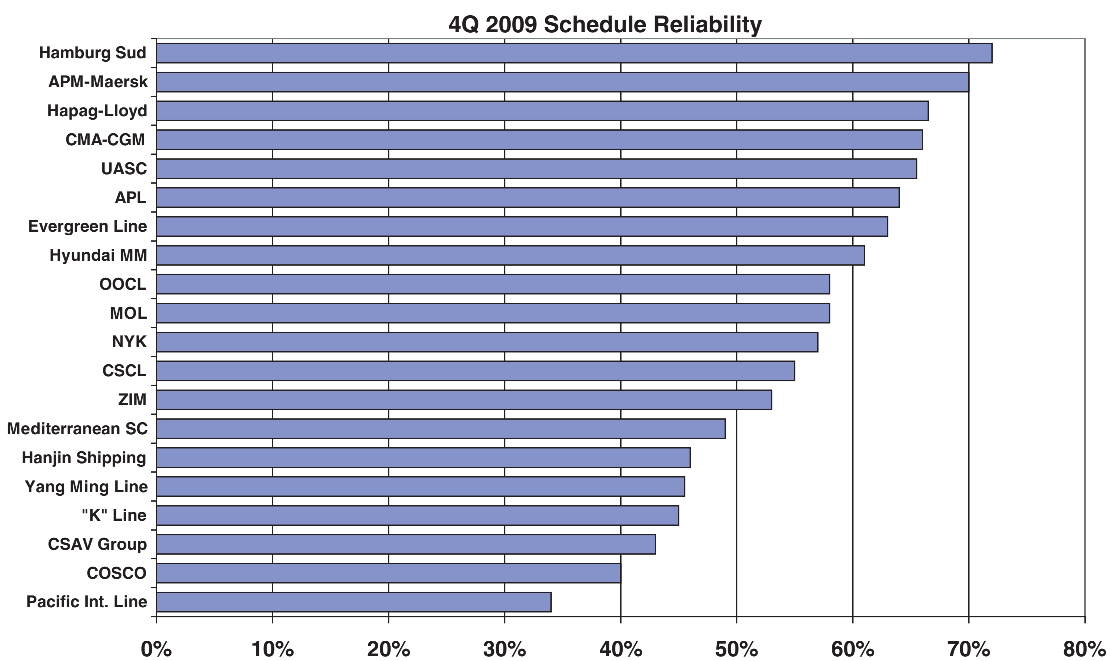
The most common disruptions to routine operations are probably late vessel arrivals or delays in handling a vessel. Because turning the vessel is the highest priority, all available resources will be used to expedite vessel handling. Access to crane-side container stacks is typically restricted while the cranes are serving a vessel, and the terminal may suspend receipts of containers for other voyages. If a vessel is delayed by more than a few hours, the availability of import containers from that vessel will be significantly delayed as well. This delay will, in turn, leave drayage drivers unexpectedly idle while it lasts, but doubly busy thereafter attempting to meet customer demands. The congestion multiplies when delays to one vessel prevent another from being handled on schedule.

As Figure 9–2 suggests, late vessel arrivals are common. The structure of labor contracts can lead terminal operators to delay unloading a vessel further. Since longshore labor is called on a shift basis and paid for a full shift regardless of how many hours are worked, terminal operators avoid calling longshore labor for partial shifts. A vessel that arrives partly into a shift might therefore not be handled until the start of the next full shift.

At terminals with on-dock rail facilities, a late train also can cause an unplanned diversion of resources or congest the container yard.

Terminal Changes

Changes to marine terminal processes, tenants, and facilities will disrupt drayage operations and reduce productivity for the duration of the disruption. The loss of productivity and delay to



Source: Drewry analysis for 4Q2009, cited by E. Kolding, Maersk Line, *Trans-Pacific Maritime Conference* presentation on March 1, 2010, Long Beach, CA.

Figure 9–2. On-time performance of major ocean carriers.

imports and exports depends on the way in which the change is handled as well as on the nature of the change itself.

Procedural Changes

On the lower end of the scale, marine container terminals frequently make minor procedural changes. These changes range from the way in which information is communicated at gates to the processes for handling trouble tickets. Such changes will generate temporary confusion that can be exacerbated by language differences. Drivers who regularly serve the terminal will adjust to the new procedures with the first few trips. Drivers who do not visit the terminal regularly, however, may have a longer learning period.

Minor Facilities and Operations Changes

Marine terminals likewise make frequent minor changes to facilities. Parking and stacking arrangements are changed, pavement is re-striped, and new lift equipment is put into service as needed. These changes also will result in temporary confusion; again, drivers who visit the port most frequently will adjust quickest.

New Programs and Regulations

The advent of TWIC requirements, clean truck plans, and new chassis pools has led to more extensive disruption than routine procedural or facilities changes.

New Terminals

Although the opening of new terminals invariably requires some adjustment period in which operations are anything but smooth, there are mitigating factors, as follows:

- The opening of a new terminal is usually accompanied by more detailed planning and communication than changes to existing terminals;
- New terminals (usually) open at far less than their ultimate capacity, giving them substantial operating slack at the outset;
- Stevedores and ocean carriers routinely assign their most experienced and successful staff to assist in the opening of new terminals; and
- Although new equipment and systems have "teething" problems, they also are generally free of "make do" legacy accommodations.

As a result, most new terminals go through only a brief adjustment period.

Persistent Congestion

The serious, port-wide congestion at Los Angeles and Long Beach during the peak season of 2004 received widespread media and industry coverage. The congestion resulted from unanticipated cargo growth coupled with a longshore labor shortage and disruptions to UP rail service. The outcome was an inability to move cargo through the terminals fast enough for peak season volumes (which average 11% above the annual average throughput at LALB). During the worst period, over 100 vessels were waiting in San Pedro Bay to be unloaded, and terminals were diverting all available resources to handling the vessel backlog.

There were the following multiple, compounding repercussions for drayage:

- As terminals filled up with containers that should have been moving elsewhere, inventories and location systems fell behind, making it harder and more time-consuming to locate and transfer the correct container;
- The shortage of longshore labor and the priority given to vessel operations meant that the shortfall would be most keenly felt in gate, clerical, and CY operations that support drayage;
- Drayage firms found themselves unable to efficiently return containers in their possession, yet were being charged demurrage for keeping them beyond the authorized free time; and

- As delivery of import containers fell farther behind, import customers became more insistent on retrieving the highest priority containers, thus reducing the drayage firms' flexibility.

Ocean Carrier Tenant Shifts

Occasionally, ocean carriers change terminals. This may occur when a new terminal becomes available, when a carrier changes consortium or vessel sharing partners, or for a variety of other operational or financial reasons.

At a minimum, a shift will lead to a brief period of confusion as drivers who had not previously served that terminal learn the system, ocean carrier staff establish operations there, and equipment is repositioned (remember that at any given time, a substantial part of the container and chassis inventory may be in the hands of drayage drivers or customers). The shift will go relatively smoothly, if the new terminal has ample capacity and similar management and systems.

More serious disruptions can occur when the terminal is not adequately prepared for the new client line or the trade volume. The immediate symptoms of the problem will be long turn times and very long gate queues. In some cases, these lines have caused the port authority to change the traffic patterns around the marine terminal, blocked access to neighboring freight facilities, and forced port police to send draymen away from the terminal.

The terminal often responds by working longer hours, adding special gates to increase capacity, and adding remote parking facilities for loads and empties to increase CY capacity. Longer working hours are a temporary measure that cannot be sustained without a long-term increase in the workforce. Remote lots create additional work.

Planning and Communication

The logical antidote to poorly planned or poorly understood changes is better planning and communication, a theme echoed in other sections of the guidebook. The ongoing port community meetings cited as best practices are a potential vehicle for informing the relevant stakeholders regarding upcoming changes and obtaining feedback.

Container Yard Solutions

Drayage firms and drivers have a long-standing—and apparently valid—complaint that all other terminal processes slow or stop when terminals divert available resources to serve a vessel, particularly if that vessel is late. This study did not attempt to prescribe changes in terminal operations or resources. It is clear, however, that ocean carriers and terminals that economize by having only enough resources to accomplish *part* of the overall transportation task simultaneously are doing their customers a disservice in the long run.

One promising approach is to design the terminal so truck and vessel operations do not overlap or share equipment. The APM Portsmouth terminal and the proposed Ports America terminal for Oakland are examples of designs with container stacks perpendicular to the vessel. These stacks are served by one set of gantries to load and unload the vessel from the berth end, and by a second set of gantries to load and unload drayage trucks on the CY end.

Such large-scale investment and reconfiguration is beyond the short-term need and capability of most port terminals. A more modest means of improvement would be to ensure enough lift equipment and staffing to handle both vessels and trucks in existing configurations. It is likely that this kind of marine terminal staffing commitment will only come as shippers and receivers work actively with the stakeholders to address drayage turn time costs.

CHAPTER 10

Extra Drayage Trips

Dry Runs

So-called "dry runs" result from uncompleted transactions, often due to the same kind of information and process issues reflected in the previous trouble ticket discussion. These dry runs add cost, time, and emissions but achieve no transportation purpose. There are a wide variety of other circumstances in which drayage drivers are adding trip legs, miles, and time to their movements as a result of changing business and operating practices at the port terminals. In many cases, these extra trips have become the new norm.

A dry run occurs when a trucker goes to the marine terminal but is unable to complete the assignment. For example, a dry run might result when a driver arrives at the terminal to pick up an import load before the load has been released. Depending on the kind of cargo, an import container must be released by one or more government agencies. In addition, a terminal will not release a container until all the freight charges including detention are paid.

The team identified a number of trouble ticket categories that could result in dry runs. Trouble tickets likely to cause dry runs were found to be a smaller subset of all trouble tickets than the team expected. The study team notes that terminals generally have made significant efforts to improve electronic communication between themselves and motor carriers, and likely have reduced the frequency of dry runs over the past several years.

Dry runs impose a financial burden on the motor carrier. The study's most egregious anecdote was reported by a Canadian motor carrier serving the Port of New York and New Jersey. In order to ensure speedy delivery of the cargo, his customer requires him to dispatch drivers from Canada to New York the day before the cargo becomes available in Northern New Jersey. If the cargo remains unavailable for some reason, the drivers may wait several hours until the cargo is discharged and cleared. If, however, the problem happens on a Friday, the motor carrier brings its drivers back to Canada, pulling a bare chassis, only to return for the payload on Monday.

Extra Empty Equipment Moves

Occasionally, empty equipment must be shuttled to where it will be more useful. These movements correct imbalances and occur in a number of different circumstances. Examples include the following:

- Vessel sharing agreements often result in marine or rail terminals having custody of empty equipment that the ocean carrier wants loaded on a ship at a different marine terminal. The result is an empty move between the two marine terminals.

- Sometimes surplus equipment builds up at a local or inland CY, rail terminal, motor carrier, or marine terminal. Again, the result is an empty move between terminals.
- Regional chassis pool providers regularly experience equipment imbalances requiring empty drayage movements to supply chassis in locations where they are needed.
- Pool chassis are not yet fully interchangeable, and motor carriers sometimes find themselves at a terminal that will accept an empty or loaded container but not the chassis on which it is mounted. This generates a separate move to a chassis depot.

The common thread is that these movements are a cost to be minimized and, to the extent to which they can be avoided, they are extra trips for the marine carriers and equipment providers who pay for them.

Return Moves to Satellite Locations

The Uniform Intermodal Interchange Agreement (UIIA) defines the standard terms under which transportation companies transfer custody of equipment such as trailers, containers, and chassis. Until recently, the UIIA required the motor carrier to return the equipment to the location where it was obtained. The contract requirement was that an import container taken from a marine terminal would be required to be promptly returned to that marine terminal.

The same investment in improved communications between marine carriers, terminals, and motor carriers that reduces the frequency of dry runs also provides the intermodal community with the agility to direct, on short notice, the return of equipment to its optimal location, thereby avoiding some of the repositioning costs described above. As a result, the UIIA was modified in November 2009, to match an emerging industry practice. The change highlighted in the following paragraph offers the prospect of eliminating a fraction of the cost associated with balancing empty equipment.

> Absent a separate bilateral agreement in written or electronic form between the Parties, the Motor Carrier shall use the Equipment for only the purposes for which it was interchanged, not authorize use by others, and promptly return the Equipment after its interchange purpose is complete. The Motor Carrier shall return the Equipment to the physical location at which the Equipment was received unless the Provider directs the Equipment to be returned to satellite locations as governed by (1) a written bilateral agreement between the Parties or (2) a notification from the Provider to the Motor Carrier via internet posting, e-mail, or shipping order. Satellite location(s) are facilities which are within the same local commercial territory and support operations of the Provider for the location from which the Equipment was originally received. Whenever a return location is changed, Provider must notify the Motor Carrier by e-mail by 16:00 P.M. local time the business day prior to the change becoming effective. Motor Carrier must furnish the Provider with e-mail addresses to be used for Motor Carrier notification when return locations are changed.[3]

As a result, an import container taken from a marine terminal and made empty by a customer may be required to be returned to a nearby CY, rail facility, or alternate marine terminal. These rules are new, and the governing body of the UIIA is monitoring the use of this increased flexibility. Motor carriers are concerned that they will be required to provide a service that is different and more costly than originally offered.

The result of this change has been an increase in the complexity of motor carrier operations and an increased likelihood of a dry run caused by returning an empty to the wrong location. The level of complexity is illustrated by Figure 10–1, which provides drayage drivers 143 separate instructions involving 11 different marine carriers, 7 different locations within a heavily congested 5-mile radius, and occasionally requires the line to be contacted directly.

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[3] Uniform Intermodal Interchange & Facilities Access Agreement, May 2010, page 3.

PNCT Empty Locations

Effective TUESDAY 2/16/2010 FOR RETURN

Shipping Line	20' Dry	20' Open Tops	20' Flat	20' Reefers	Hangers	40' Dry	40' Open Tops	40' Flat	40' High Cubes	40' High Cube Reefers	45' High Cube	Reefers With Gensets	Reefers With Gensets Chassis
MSC	EMPTY DEPOT	PNCT	PNCT	PNCT	Call MSC	PNCT	PNCT	PNCT	EMPTY DEPOT	PNCT	PNCT	PNCT	PNCT
Remarks: Empty Depot is located at 103 Marsh Street. PICK UP EMPTY 20' DRY + 40' HIGH from EMPTY DEPOT on Marsh Street. All other empty pick up at PNCT main terminal. RETURN MAJOR DAMAGED EMPTIES to EMPTY DEPOT on MARSH STREET													
APL	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny	APL S. Kearny
China Shipping	PNCT	IRONBOUND	IRONBOUND	PNCT	IRONBOUND	PNCT	IRONBOUND	IRONBOUND	PNCT	PNCT	PNCT	PNCT	IRONBOUND
Remarks: All China Shipping 40' dry + 40' high containers picked up at CSX South Kearny should be returned to CSX South Kearny. All 20' drys from CSX should be returned to Ironbound - Delancy St.													
CMA/ANL	APM TERMINAL	PNCT	PNCT	ASI	APM TERMINAL	APM TERMINAL	PNCT	PNCT	PNCT	ASI	APM TERMINAL	ASI	ASI
Remarks: OFFHIRE PREFIXES YOU NEED TO CALL 757-961-2103 . FBXU, GCNU, DBKU, MSGU, TRDU, ACCU, CIIU, EAGU, CPIU, ACLU													
COSCO	PNCT	Maher - berth 64	Maher - berth 64	Maher - berth 64	Maher - berth 64	PNCT	Maher - berth 64	Maher - berth 64	PNCT	Maher - berth 64	Maher - berth 64	Maher - berth 64	Maher - berth 64
Remarks: Cosco is using the NERP (NYK and OOCL) chassis pool for import and export cargo at PNCT. All damaged Cosco empties shoudl be returned to Container Services of New Jersey. Any customer service problems at PNCT, cal Eric @ 201-422-0500 ex 8494 or e-mail enordstedt@cosco-usa.com													
CSAV - LIBRA	PNCT	PNCT	PNCT	PNCT		PNCT	PNCT	PNCT	PNCT	PNCT	PNCT	PNCT	PNCT
Remarks: CSAV and Libra use Metro Pool chassis													
Evergreen	PNCT	PNCT	PNCT	MAHER - BERTH 64	CALL EVERGREEN	PNCT	PNCT	PNCT	PNCT	PNCT	PNCT	PNCT	PNCT
Remarks: EVERGREEN USES METRO POOL CHASSIS.													
HLL - Hapag Lloyd	IRONBOUND	IRONBOUND	IRONBOUND	IRONBOUND	IRONBOUND	PNCT	IRONBOUND	PNCT	PNCT	IRONBOUND	IRONBOUND	IRONBOUND	IRONBOUND
Remarks:													
Maersk/P&O	APM TERMINAL	APM TERMINAL	APM TERMINAL	APM TERMINAL	APM TERMINAL	APM TERMINAL	APM TERMINAL	APM TERMINAL	APM TERMINAL	IRONBOUND	APM TERMINAL	IRONBOUND	IRONBOUND
Remarks:													
NYK	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL	GLOBAL
Remarks:													
OOCL	IRONBOUND	IRONBOUND	IRONBOUND	CALL OOCL	IRONBOUND	IRONBOUND	IRONBOUND	IRONBOUND	IRONBOUND	CALL OOCL	CALL OOCL	CALL OOCL	CALL OOCL
Remarks:													

Figure 10–1. PNCT empty return instructions for 2/16/2010.

Empty return matrices such as the example shown in Figure 10–1 are becoming a common communication tool at marine terminals and ports. Often, the matrices are posted on Web sites or made available in electronic bulletins. Empty return instructions also are transmitted by eModal.

The study team found that frequent changes in empty return instructions could result in increased dry runs and delays. With the potential to change daily or even during the day, varying empty return requirements disrupt driver and dispatcher efforts to optimize drayage trips. It is common for drayage firms to create a morning dispatch plan and communicate the plan to drivers the night before. This approach is essential when drivers can start work from multiple locations as early as 4:30 A.M. Changes to empty return instructions made after the dispatch plan is communicated are likely to result in some drivers draying empties to the wrong location.

Drayage operators have legitimately questioned the need for empty return instructions to change so often or with such short notice. It may be that the disruption to drayage operations outweighs the benefits of fine-tuning container supplies on a daily basis.

Auxiliary Depots

Driven by the need to handle an increasing volume in a fixed space, Maher and Port Newark Container Terminal (PNCT) developed auxiliary container depots at the Port of New York and New Jersey. These depots effectively become part of the marine terminal operation without consuming the most valuable shipside land. They have separate gates and serve to divert a meaningful share of gate transactions away from legacy gate facilities.

This practice is illustrated in the instructions in Figure 10–1, which require a motor carrier with a 20-ft dry container to return the box to the PNCT Empty Depot, which is located less than a mile away from the main terminal. It is likely that a motor carrier seeking an empty Mediterranean Shipping Company (MSC) container for an export load would be directed to pick up the box at the empty depot.

The system has the following disadvantages for the motor carrier:

- The effective terminal area is larger and more spread out. Intra-terminal moves have been replaced with street moves of much longer distance and duration.
- The system generates an increased number of gate transactions and queues.

These disadvantages are partially mitigated as follows:

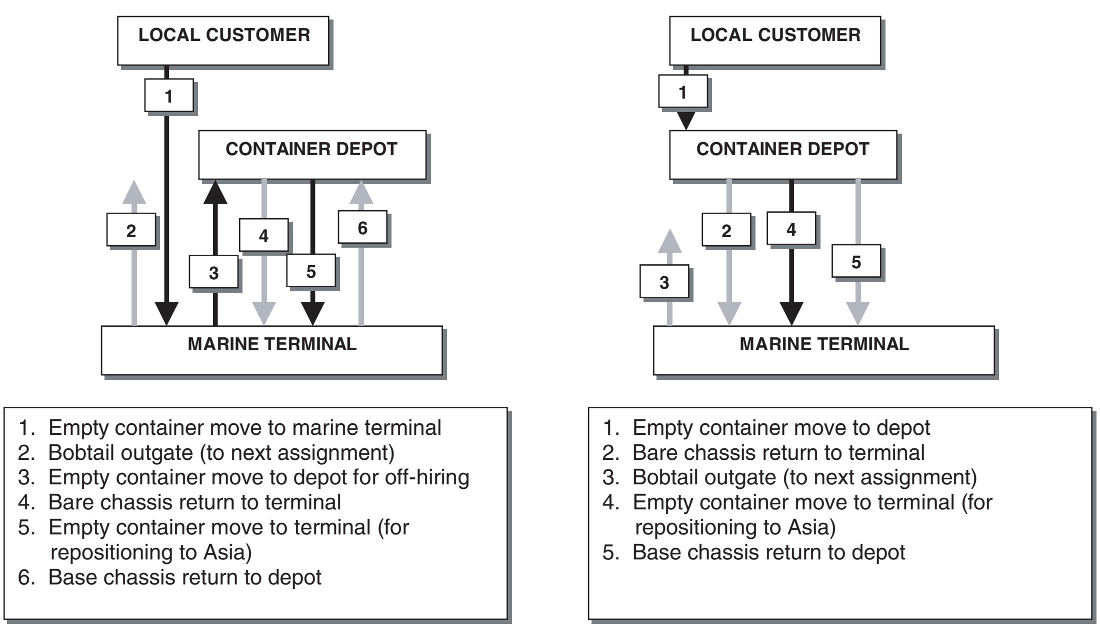
- Queues and turn times for simple transactions involving the empty container depot may involve less congestion and be less costly than performing them at the main marine terminal.
- Separation of these functions leads to more specialized service.

For NYNJ motor carriers, complications and complexities arise because there are at least three different systems for providing chassis in the port. At APM, the lines provide the chassis; at Maher, there is a mandatory co-op chassis pool; at the other facilities, there is a voluntary neutral chassis pool. With vessel sharing agreements and the interplay of landbridge and Atlantic marine international operations, it is not uncommon for the box to be delivered in one place and the chassis in another.

The process of off-hiring and repositioning an empty container to a depot can require six one-way truck trips (as shown in Figure 10–2a) if the container is first returned to the marine terminal.

Moving the empty directly to the depot can cut at least one truck trip from each off-hiring and repositioning cycle, making a total of five instead of six one-way truck trips (as shown in Figure 10–2b).

Empty returns can generate delays or exceptions if demurrage charges are due because the container has been kept too long, if the container or chassis is damaged, or if the container interior is not clean and empty. Demurrage charges can be a major source of contention between



(a) Current off-hiring. (b) Depot direct off-hiring.

Figure 10–2. Depot off-hiring trips.

drayage firms and ocean carriers. Such issues arising at entrance gates are likely to result in trouble tickets. Issues arising over damage to the container or chassis also will result in a trouble ticket and a delay. Empty containers returned with soiling or the remnants of packing materials are a special problem for drayage drivers. In principle, the driver should have checked the interior condition when picking up the empty container form the consignee. Time pressure or recalcitrant employees at the consignee's loading dock may, however, saddle the driver with a dirty or cluttered unit. If so, the driver must empty and clean the unit before it will be accepted at the marine terminal. Too often, the driver winds up dumping any remnants of packing, broken pallets, and other debris by the side of the road or in a vacant lot.

Because the ultimate origin and destination of the box and chassis are uncertain at time of pick up, the motor carriers have sought relief under the provisions of the UIIA, which obligates the motor carrier only to return the equipment to the pick-up point.

Motor Carrier Shuttles and Drayoffs

Motor carriers with nearby terminals often make shuttle moves between marine and motor carrier terminals. These shuttle moves serve some of the following purposes:

- The shuttle drivers are very savvy regarding marine terminal services and can complete the marine terminal processes more quickly than less experienced drivers.
- A shuttle may buffer and extend the practical range of a long- or medium-haul operation. The over-the-road driver turns at the local terminal rather than at the marine terminal.
- The shuttle service may be necessary if the motor carrier's other drivers do not have the proper credentials to enter the marine terminal (TWIC or Sea Link) or has a tractor that does not meet port emission standards.
- Particularly for firms with company drivers, it may pay a motor carrier to use shuttle moves to fill a driver's work day.

Shuttle or drayoff operations break what would have been single trip legs into two parts: a move between marine terminal and motor carrier terminal, and a second trip between the motor carrier terminal and the customer. The reverse takes place on the return trip. These practices add miles and time to the drayage move, but may be the most efficient way for the trucking company to handle business. A handoff is almost certainly preferable to sending a non-eligible or unfamiliar driver and tractor into the marine terminal.

It is likely that these practices will increase with the spread of TWIC, clean truck programs, RFID requirements, and other factors that distinguish port drayage as a specialized business. Increased complexity appears to be a necessary cost of achieving security and emissions goals. The upside of these practices is that more of the drayage business will be handled by knowledgeable, experienced, and specialized firms capable of increasingly efficient port drayage operations.

Extra Trip Solutions

Planning and Communications

In site visits and from other contacts, the study team observed a high degree of operational planning at both marine terminals and drayage firms. Those plans, however, are neither coordinated nor shared. Communications are essentially one-way marine terminal Web sites and announcements. Some marine terminal operators use booking and vessel manifest information to gauge likely gate volumes and labor requirements for the next day, but most confine that planning effort to labor that handles the CY and the vessel.

Drayage firms around the country have repeatedly expressed a desire for stable, predictable, and coordinated operating practices among the marine terminals at a port. These include

- The same gate hours and functions at all terminals,
- The same identification and documentation requirements at all terminals, and
- Consistent empty return instructions that do not change from day to day or on short notice.

The main function of a marine terminal is to unload and load the vessels of its primary customer, the ocean carrier. All other terminal functions, including efficient handling of drayage requirements, are subordinated to vessel handling.

This reality is reflected in the common practice of marine terminals to close off portions of the terminal to drayage drivers or restrict the drayage functions available while working a ship. These are practices that result in drayage dry runs and delays.

Equipment control (i.e., management of containers and chassis) is an important marine terminal and ocean carrier function but apparently does not receive full attention in the presence of vessel handling requirements. A 2003 study[4] of empty container logistics in Southern California found that ocean carrier and marine terminal equipment control personnel waited until excess empties accumulated in the terminal before having them drayed to an off-terminal depot. It was confirmed that common terminal operating systems permitted proactive equipment control by issuing alternative empty return instructions when the loaded container was released, but that feature was not being used.

Experienced and well-organized drayage firms can attempt to optimize operations under almost any circumstances if those circumstances are reasonably stable and consistent. Inconsistent and unstable circumstances put up barriers to efficient dispatching and operations that ultimately cost drayage firms and their customers time and money.

It would be unreasonable to expect joint planning between multiple marine terminals, multiple ocean carriers, and hundreds of drayage firms. It would appear reasonable, however, for marine terminals to set empty return instructions proactively so that they could remain unchanged for a week or more. It also would be valuable for marine terminals to provide advance notice of any changes in gate hours, functional restrictions, or other changes that should be reflected in drayage dispatch plans.

[4] The Tioga Group, Inc., *Empty Ocean Container Logistics Study,* Gateway Cities Council of Governments, Port of Long Beach, and Southern California Association of Governments, May 2002.

CHAPTER 11

Congestion on Streets and Highways

Port-Area and Port Access Congestion

Port-area road capacity and congestion have become a serious problem, particularly where growth in both port traffic and surrounding urban traffic has outpaced road and highway capacity. Marine container terminals are typically established away from congested urban centers in areas with relatively little development. Over time, however, the area around the terminal fills in with industrial and commercial development. Both the marine terminal and the adjacent land uses generate a growing volume of traffic, and denser development makes road improvements more difficult and costly.

Reliability and predictability of port-area road conditions and travel times also are a factor in minimizing gate congestion and queuing. For example, a drayage driver facing a predictable 1-hour trip to a terminal gate that opens at 8 A.M. can leave at about 7 A.M. and arrive at the gate on time. If the drive takes anywhere from 60 to 90 minutes, however, the driver will have to leave at 6:30 A.M. and frequently will have to wait for the terminal gate to open.

Container trucks are heavy. Roads serving marine terminals require heavier duty construction and more maintenance than ordinary arterials. If they are not built and maintained to adequate standards, they will deteriorate rapidly. Many port and rail terminal access roads are inadequate for their current purpose, and create delays, damage, and safety problems for drayage operations.

Congestion on urban arterials and freeways can affect any drayage move that extends beyond the immediate port area. The scope of the “immediate port area” varies by port. Houston has two well-defined terminal areas—Barbours Cut and Bayport. In contrast, the “port area” for the Ports of Los Angeles and Long Beach covers a zone about 5 miles wide and 20 miles deep, about 100 square miles, in which port drayage trips are a permanent part of the surface traffic.

As Figure 11–1 and Figure 11–2 illustrate, many port drayage trips extend far beyond the port area. The distribution for PANYNJ (Figure 11–1) reflects clustering of importers, exporters, and related drayage trip generators near the port and a broader hinterland about 200–300 miles away. The distribution for LALB (Figure 11–2) is much tighter, with around 60% of the trips contained within the 20-mile-deep port area, and most of the rest moving to and from other ports of Southern California. The difference is because most longer trips to and from LALB are made by rail; there are few significant population areas in easy trucking distance from the San Pedro Bay ports.

The PANYNJ truckers making 200- to 300-mile trips to the hinterland will be using a mix of urban and rural highways and freeways, with a mix of more or less congested conditions. Trips to and from LALB, however, are almost all made over congested urban routes.

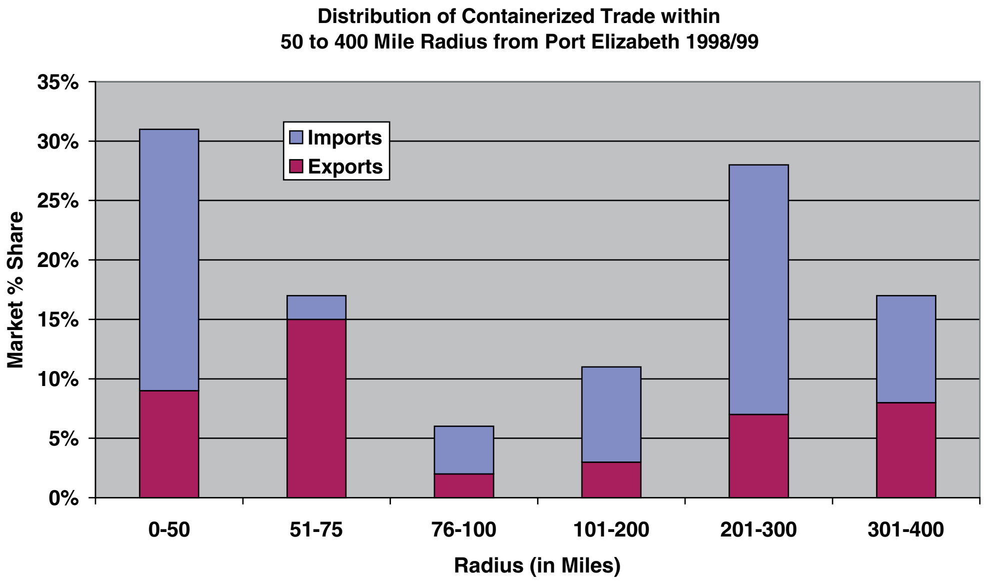


Figure 11–1. PANYNJ drayage distances.

Other than the geographic location of most container ports in dense urban areas, there is nothing unique to drayage about congestion on urban roads and freeways. Any truck traveling to, from, within, or through those urban areas will experience the same delays.

Broad national and regional estimates of the cost of congestion are applicable to port drayage. One potentially significant difference, however, is that drayage drivers are usually paid by the trip, receiving a percentage of the drayage companies' revenue from the customer. A drayage

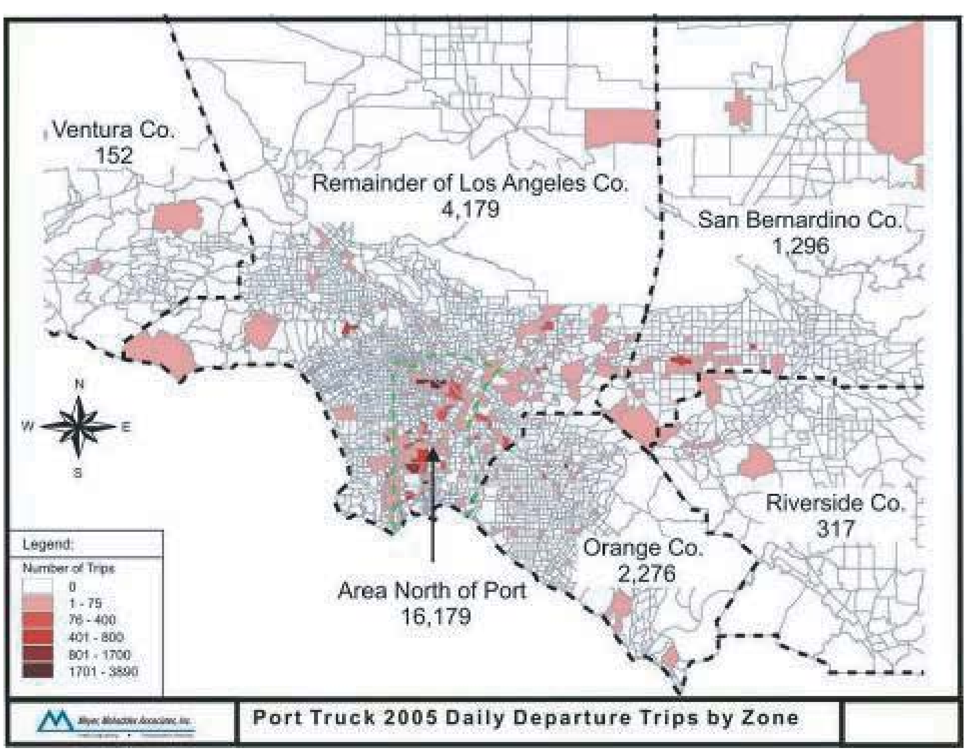


Figure 11–2. Port of LALB truck trips from survey.

Table 11–1. Ranking of freight bottleneck severity based on ATRI analysis.

Total Freight Congestion Value	Ranking Using ATRI Analysis	Bottleneck Name/ Location	County/State
2722629	1	I-80 @ I-94 split in Chicago, IL	Cook, IL
1435661	2	I-95 @ SR-4	Bergen, NJ
921688	3	I-90 @I-94 Interchange ("Edens Interchange")	Cook, IL
899899	4	I - 285 @ I - 85 Interchange ("Spaghetti Junction")	Dekalb, GA
656190	5	I-95 @SR-9A (Westside Hwy)	New York, NY
446933	6	I-40 @ I-65 Interchange (east)	Davidson, TN
426569	7	SR-60 @ SR-57 Interchange	Los Angeles, CA
382200	8	I-10 @ I-15 Interchange	San Bernardino, CA
318853	9	I-45 (Gulf Freeway) @ US-59 Interchange	Harris, TX
259704	10	I-45 @ I-610 Interchange	Harris, TX
234258	11	I-20 @ I-75/I-85 Interchange	Fulton, GA
225892	12	I-17 (Black Canyon Fwy): I-10 Interchange (the "Stack")	Maricopa, AZ
183772	13	I-95/I-495	Prince Georges, MD
156987	14	I-710 @I-105 Interchange	Los Angeles, CA
144772	15	I-71 @ I-70 Interchange	Franklin, OH
144009	16	I-80 @ I-580/I-880 in Oakland, CA	Alameda, CA
138824	17	I - 75 @ I - 85 Interchange	Fulton, GA
129421	18	I-880 @ I-238	Alameda, CA
119629	19	I-695/I-70 and I-95 exit 11 (note: I-70 N. of here)	Baltimore, MD
115516	20	I-10 @ I-110/US-54 Interchange	El Paso, TX
107116	21	I-25 @ I-76 Interchange	Adams, CO
93066	22	I-10 @ I-410 Loop North Interchange	Bexar, TX
58784	23	I - 285 @ I - 75 Interchange	Cobb, GA
56591	24	I-290 @ I-355 Interchange	DuPage, IL
51486	25	I-10 @ SR-51/SR-202 Interchange ("Mini-Stack")	Maricopa, AZ
40647	26	I-110 @ I-105 Interchange	Los Angeles, CA
36746	27	SR-91 @ SR-55 Interchange	Orange, CA
28291	28	I-95 @ I-595 Interchange	Broward, FL
16732	29	I-405 (San Diego Fwy) @ I-605 Interchange	Orange, CA
3200	30	SR-134 @ SR-2 Interchange	Los Angeles, CA

Source: *Freight Performance Measures Analysis of 30 Freight Bottlenecks,* ATRI, March 2009.

driver's income depends on how many trips the driver can make in working hours. Other intercity truck drivers are more commonly paid by the authorized mile, regardless of how long the trip takes. The impact of congestion on the drayage drivers' income therefore depends on the ability of the drayage firm to reflect expected congestion impacts in its rate structure.

Table 11–1 shows a ranking of the 30 worst U.S. freight bottlenecks, based on an FHWA/ATRI study of GPS data. A number of the bottlenecks shown are in port regions, notably Southern California, Houston, and New York.

The impact of port-area congestion is well documented in previous national reports. The Bureau of Transportation Statistics noted that a 2005 U.S. Maritime Administration (MARAD) report estimated that landside access challenges cost as much as $200 billion annually and wasted 2.3 billion gallons of fuel.[5] The same study provided estimates of average annual peak-period traffic delays per traveler in major port regions (Table 11–2). The three case study areas for this project are at the top of the table, with averages of 56 hours for Houston, 72 hours for LALB, and

[5]*America's Container Ports,* BTS, 2009.

Table 11–2. U.S. port activity and urban traffic delay, 2007.

Ranked by port calls by all vessel types	Port	Port calls and capacity by all vessel types: Calls	Capacity (dwt, millions)	Overall maritime cargo tonnage (domestic and international): Total short tons (millions)	Rank by tonnage	Landside annual traffic delay per traveler in surrounding urban area (2005)[1]: Hours of delay	Rank
1	Houston, TX	6,195	267	216	2	56	7
2	Los Angeles/Long Beach, CA	5,492	336	151	4	72	1
3	New York, NY	4,968	232	157	3	46	16
4	New Orleans, LA	4,884	240	76	9	18	63
5	San Francisco Bay Area ports, CA[2]	3,945	213	48	17	60	2
6	Philadelphia/Delaware River ports, PA[3]	3,148	192	111	5	38	33
7	Virginia ports, VA[4]	2,775	138	56	15	30	42
8	Savannah, GA	2,615	122	36	23	NA	NA
9	Columbia River ports, OR[5]	2,578	100	56	14	38	33
10	Charleston, SC	2,160	97	23	33	31	40
11	Baltimore,MD	1,833	63	41	20	44	22
12	Port Everglades, FL	1,472	52	24	32	NA	NA
13	Jacksonville, FL	1,470	43	21	35	39	29
14	Port Arthur, TX	1,418	95	29	27	11	77
15	Tacoma, WA	1,241	63	27	29	45	19
16	Texas City, TX	1,200	70	57	13	56	7
17	Corpus Christi, TX	1,080	72	81	7	10	80
18	San Juan, PR	1,045	23	12	45	NA	NA
19	Seattle, WA	1,042	60	28	28	45	19
20	Miami, FL	927	31	7	56	50	11
21	Mobile, AL	885	47	64	10	NA	NA
22	Freeport, TX	806	40	30	26	NA	NA
23	Tampa, FL	800	29	47	18	NA	NA
24	Lake Charles, LA	796	56	64	11	NA	NA
25	Honolulu, HI	648	21	18	37	24	51

KEY: dwt = deadweight tons. NA = Not available in the Texas Transportation Institute 2007 Annual Urban Mobility Study.

1 The most recent year for which data on landside annual traffic delay are available is 2005. Annual delay per traveler equals extra travel time for peak-period travel during the year divided by the number of travelers who begin a trip during the peak period (6 to 9 a.m. and 4 to 7 p.m.). These peak-period travel times are compared wih times for free-flow speeds (60 mph on freeways and 35 mph on principal arterials).

2 San Francisco Bay Area ports: Oakland, Redwood City, Richmond, San Francisco, and Stockton.

3 Philadelphia/Delaware River ports: Philadelphia, Paulsboro, Marcus Hook, Camden-Gloucester, Chester, and Wilmington.

4 Virginia ports: Norfolk, Richmond, and Newport News.

5 Columbia River ports: Portland, Longview, Vancouver, and Kalama.

SOURCES: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, based on data from three sources. Port calls data: Maritime Administration, Ports Calls Data, at www.marad.dot.gov, as of Mar. 31, 2009. Cargo weight data: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, at www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm, as of Mar. 31, 2009. Traffic delay data: Texas Transportation Institute, 2007 Annual Urban Mobility Study, Table 1, available at mobility.tamu.edu/ums as of Mar. 30, 2009.

Table 11–3. Below-average traffic flow at key ports.

Percent of Ports Reporting Below Average Flow Conditions on Key System Elements			
		Strategic Ports	Non-Strategic Ports
Roads	Within Ports	8%	25%
	Local Access	58%	27%
	State & Interstate	45%	30%

Source: *Intermodal Access to U.S. Ports Report on the 2002–2003 Survey Findings,* MARAD, 2003.

Table 11–4. Reasons for below-average port-area traffic flow.

Percent of Ports Reporting a High Percentage of Below-Average Conditions for Other System Attributes at Strategic and Other Key Container Ports			
		Strategic Ports	Non-Strategic Ports
Roads	Number of turning lanes on local roads	33%	30%
	Turning radii on local roads	50%	33%
	Traffic flow at at-grade rail crossings within ports	42%	33%
	Traffic flow at at-grade rail crossings on local roads	58%	27%
	Signage in port	18%	17%
	Signage on local roads	33%	18%
	Signage on Interstate and State roads	50%	18%

Source: *Intermodal Access to U.S. Ports Report on the 2002–2003 Survey Findings,* MARAD, 2003.

46 hours for NYNJ. It is likely that those figures underestimate the impact on drayage operations that make multiple daily trips in the most congested areas.

A 2003 MARAD survey highlighted common congestion at large strategic ports (Table 11–3) and pinpointed some of the features that contribute to the congestion (Table 11–4).

The increasing congestion on port access routes is symptomatic of broader nationwide infrastructure issues. As the United States falls further behind in building and maintaining the roads and highways needed to support a growing population and economy, ports and the drayage firms that serve them, suffer along with most other sectors. With state, local, and federal highway and road expenditures far below sustainable levels, port drayage needs must compete with commuters, domestic truckers, and every other road user for limited funds and capacity.

Road and Highway Congestion Solutions

Infrastructure Project Participation

Although the scope of regional or even local highway infrastructure projects is often outside the influence of port drayage stakeholders, port-area improvements should provide opportunities for involvement. In the study team's experience, however, infrastructure planners rarely reach out to working truckers for their input.

Congestion on urban streets and highways is ordinarily beyond the control of terminals or truckers, but port authorities may have some influence. Extended gate hours (early morning and late evening) can assist truckers in avoiding the worst peak traffic hours and can push some port-related traffic to less congested periods. When designing programs to shift dray traffic to off-peak periods, it is important to first understand the network of pickup and delivery points served by dray trucks. If the warehouses and distribution centers only work during the normal work day, late terminal hours are not likely to produce significant shifts. If, however, the majority of deliveries are to 24-hour distribution centers, then expanded terminal hours can be effective in lessening the conflicts between dray trucks and passenger vehicles. Planners also should be cognizant that imports and exports sometimes follow distinct patterns of activity. For example, a greater percentage of imports may be tied to large 24-hour import distribution centers while exports are driven by a network of smaller shippers that are only open during the work day. Furthermore, under the owner-operator model, the majority of trucks will work the same number of hours as their respective drivers. Thus, in order for a driver to choose to shift hours to off-peak, the driver must be guaranteed a utilization rate equal to the forgone daytime hours. Finally, in all but the largest ports, the percentage of the total traffic mix represented by dray trucks will drop rapidly outside of the immediate port area. Therefore, it is important not to overstate the likely congestion benefits that might be attained by shifting a percentage of trucks to the evening hours.

The Barbours Cut Boulevard project in Houston is an example of the jurisdictional complexity that can create barriers to stakeholder involvement. Although highway departments, regional planning agencies, municipalities, and even port authorities may have staff dedicated to such projects, truckers and terminal operators do not. It can be a daunting task for drayage firms, owners, or managers to attend multiple meetings over the course of several years.

The key to successful participation in planning efforts is proactivity. The Port of Oakland was highly successful in the post-earthquake rebuilding of adjacent freeways and on-/off-ramps starting in 1989. The port had begun closer ties with local and regional planners in conjunction with dredging and military base redevelopment efforts, and continued that working relationship after the Loma Prieta earthquake. Port representatives were already known in the planning community, and the port was duly notified of meetings, comment periods, etc. As a result, the new freeway provides much better port access than the previous structure.

The formation of regional associations such as the Bi-State Truckers in NYNJ and similar organizations in Southern California and elsewhere offers a means of claiming “a seat at the table” and sharing the burden across multiple firms.

CHAPTER 12

Emissions and Cost Impacts

Overview

Purpose

Port container drayage is widely recognized as a critical emissions and congestion issue for major container ports, rail intermodal terminals, and the surrounding communities. These issues can be addressed and quantified through use of an emissions and activity model—EPA's SmartWay DrayFLEET—that accurately depicts drayage activity in terms of vehicle miles traveled (VMT), emissions, cost, and throughput, and can reliably reflect the impact of changing management practices, terminal operations, cargo volume, and diesel truck upgrades. The DrayFLEET Model, a User's Guide, and a complete report on development of the model are available on the following EPA SmartWay Web site at http://www.epa.gov/otaq/smartway/transport/partner-resources/resources-drayage.htm and also offers information about selected drayage emissions reductions strategies, such as chassis pooling and diesel retrofits.

Ports and terminals all fulfill the same basic functions, but do so in several different ways and in many detailed variations. DrayFLEET includes model options for all significant drayage functions at any port complex, even though those model options may be used rarely. The model includes the following:

- Drayage trips of all types to and from marine container terminals, for any reason;
- Drayage trips between rail intermodal terminals and marine terminals, and associated bobtail and chassis trips that may not begin or end at the port; and
- "Crosstown" trips to reposition empty import containers for export loads, to shift empty marine containers from rail terminals to depots, or to obtain empty containers from depots for export loads.

The DrayFLEET Model therefore includes a number of trips and trip types that do not begin or end at port terminals but are necessary to support the overall port container flow. The model does not attempt to account for trips for servicing, fuel, and repair; side trips for meals, rest, or errands; and trips made on non-port assignments such as domestic rail intermodal drayage.

Because volumes vary from year to year and month to month while movement patterns tend to persist, the model relies primarily on pattern indicators and proportions to estimate drayage trips, times, and mileages. This approach facilitates forward-looking or "what if" analyses of drayage activity and emissions with growing cargo volumes.

Model Approach

The model allows users to input data values typical of their port or terminal (such as annual TEU or distance to major customers) to create a base case activity and emissions estimate. The user can then make further input choices to create "what if" scenarios. DrayFLEET is distributed as a generic model for a hypothetical container port handling 2 million annual TEU. There are three basic steps to setting up the model for application to a specific port or terminal, as follows:

1. Input the port or terminal's specific base case default values,
2. Reset the default output values to create a port-specific base case, and
3. Create scenarios as required.

The DrayFLEET Model incorporates an activity-based approach. Each significant drayage trip type or activity is assigned a time and distance value. That value may be a precise empirical measurement, a weighted average, or an industry rule of thumb, depending on the data available. The model takes the total container volume handled by the port or terminal in question and determines the volume and mix of drayage activities required or implied. The time and VMT for those activities are tallied to develop port or terminal total drayage minutes and VMT.

For input to the emissions model, each activity time is divided into minutes by driving cycle component—idle, creep, transient, and cruise. Drayage time and miles also become inputs to the cost and capacity portions of the model. The drayage activity cycle is made up of idling, queuing/creeping, and driving in various combinations.

The activity modeling approach includes several key features as follows:

- Port-specific or generic default values for every variable and input;
- Accommodation of user inputs that differ from defaults;
- A streamlined user "front end" to facilitate primary inputs and "what if" scenarios;
- An embedded flow chart of port-related container trips to account for all significant movements;
- Activity tally sheets to capture default or user-specified factors for over-the-road drayage, terminal trips, etc.; and
- Summary activity model outputs in minutes by duty cycle to serve as emissions model inputs.

Figure 12–1 gives an overview of the model structure and the flow of information.

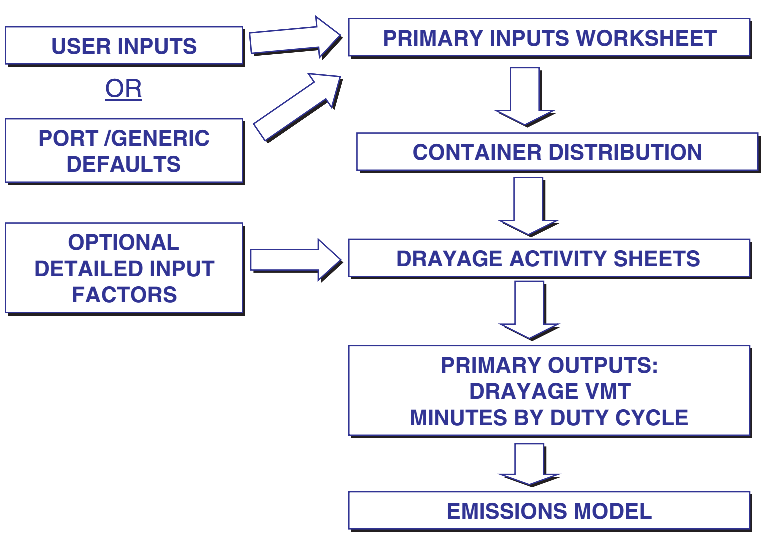


Figure 12–1. DrayFLEET model structure.

Input categories include the following:

- Port and terminal information (e.g., TEU, import/export balance);
- Default/scenario operational factors (e.g., transaction times);
- Management strategies (e.g., on-dock rail, automated gates); and
- Drayage tractor fleet and technologies (e.g., diesel engine retrofits).

Outputs provided include the following:

- Activity outputs (e.g., trip legs and VMT);
- Duty cycle outputs (e.g., idle, creep, transient, and cruise minutes); and
- Comparison charts to illustrate changes from defaults.

Figure 12–2 shows the primary inputs worksheet. This worksheet (shown in its entirety) has five sections covering key input values, port or terminal management initiatives, activity outputs, emissions and cost outputs, and a note section to identify the model application and scenario.

For each of the primary inputs there is a default value and a scenario value. The model uses the default value unless it is superseded by a different user entry in the scenario columns. The key port and terminal inputs specify the overall volume and pattern of container movements. The generic model version offers the user convenient starting points to avoid having to input every variable. The user can replace other defaults with specific scenario information as available.

Emissions Estimates

DrayFLEET calculates emissions by combining the amount of time that trucks spend within various modes of operation (idle, creep, transient, and cruise) with EPA emissions rate data specific

SmartWay DrayFLEET Version 1.0 Primary Inputs & Outputs — DrayFLEET Version 1.0d of 06/10/2008

Primary Inputs	Default	Scenario
Port		
Calendar Year	2007	2007
Annual TEU	2,000,000	2,000,000
Average TEU per Container	1.75	1.75
Inbound Share	50%	50%
Inbound Empty Share	5%	5%
Outbound Empty Share	25%	25%
Rail Intermodal Share	25%	25%
Marine Terminals		
Average Inbound Gate Queue Minutes	15	15
Average Marine Terminal Min. per Transaction	30	30
Rail Terminals		
Weighted Average Miles from Port	5	5
Average Inbound Gate Queue Minutes	5	5
Average Rail Yard Min. per Transaction	15	15
Container Depots		
Weighted Average Miles from Port	2	2
Share of Empties Stored at Depots	10%	10%
Container Shippers/Receivers		
Weighted Average Miles from Port	25	25
Weighted Average Crosstown Trip Miles	10	10
Cost Factors		
Average Drayage Labor Cost per Hour	$ 12.00	$ 12.00
Average Diesel Fuel Price per Gallon	$ 4.00	$ 4.00

Initiative Inputs	Default	Scenario
Port/Terminal Initiatives		
Stacked Terminal (% stacked)	0%	0%
On-Dock Rail (% of rail on-dock)	0%	0%
Automated Gates (% of gate transactions)	0%	0%
Extended Gate Hours (% off-peak, 50% max)	0%	0%
Container Info System (% used)	0%	0%
Virtual Container Yard (% available)	0%	0%
Neutral Chassis Pool (% used)	0%	0%

Port	
Terminal(s)	
Scenario	
Date	

Activity Outputs	Default	Scenario	Change	% Change
Annual Activity				
Number of Drayage Trip Legs	3,498,452	3,498,452	0	0.0%
Drayage Trip Legs per Container	3.1	3.1	0.0	0.0%
Total Drayage VMT	65,706,753	65,706,753	0	0.0%
Drayage VMT per Container	57.5	57.5	0.0	0.0%
Fleet Required (FTE Tractors)	1,224	1,224	0	0.0%
Annual Duty Cycle Totals				
Idle Hours	1,869,294	1,869,294	0	0.0%
Creep Hours	994,223	994,223	0	0.0%
Transient Hours	572,700	572,700	0	0.0%
Cruise Hours	1,506,026	1,506,026	0	0.0%
Total Drayage Hours	4,942,243	4,942,243	0	0.0%
Drayage Hours per Container	4.3	4.3	0.0	0.0%

Emissions Outputs	Default	Scenario	Change	% Change
Pollutant (annual tons)				
HC	53	53	0.00	0.0%
CO	298	298	0.00	0.0%
NOx	1,108	1,108	0.00	0.0%
PM_{10}	37	37	0.00	0.0%
$PM_{2.5}$	31	31	0.00	0.0%
CO_2	88,497	88,497	0	0.0%
Fuel Use and Total Cost				
Fuel - Gallons	7,909,626	7,909,626	0.0	0.0%
Total Drayage Cost	$ 159,451,797	$ 159,451,797	$ -	0.0%
Drayage Cost per Container	$ 140	$ 140	$ -	0.0%

Figure 12–2. Primary inputs worksheet.

to those operating modes for a given fleet age distribution. Loaded and empty emissions are calculated separately. The emissions rate data are already part of the DrayFLEET Model and the amount of time spent within each mode comes directly from the activity module.

Four operating modes are included in the DrayFLEET Model: idle, creep, transient, and cruise. The activity portions of the model yield estimates of minutes spent by drayage tractors in each of these modes. As of September 2010, the emissions portion of the model uses a mode conversion factor to bridge the gap between the detailed drayage activity model output and the emissions factors in MOBILE 6.2. Subsequent versions of the model will be updated to use the current EPA emissions methodologies.

Port-Area Emissions Estimates

The percentage impact of these or any emissions or activity changes depends on the context. Emissions inventories typically define a target area in the near vicinity of the port, consistent with the limited ability of the port or the terminal operators to affect drayage activities outside the port area. DrayFLEET, on the other hand, captures the full range and impact of port-related drayage activity at any distance. To do so, DrayFLEET uses weighted average distances to off-dock rail terminals, container depots, and—most critically—shippers and receivers. Rail terminals and container depots are typically within a few miles of the port, but shippers and receivers can be spread out over a broad region.

A major limitation on the percentage impact of marine terminal efficiency or emissions measures is the share of all drayage activity associated with the marine terminals. Figure 12–3, extracted from the generic model activity summary, highlights the trips, miles, and hours in the various major activity categories. The marine terminal accounts for about 76% of the trips, but only 25% of the miles and 49% of the hours. Shipper/receiver movements account for 41% of the trips, but 67% of the miles and 41% of the hours.

The miles and hours generated by drayage trips to and from distant customers can outweigh and obscure the impacts of port-area changes. Figure 12–4 provides an example of this relationship. In this figure, the 25-mile default value for the weighted average trip to shippers and receivers was changed to 5 miles. That change reduced drayage VMT by 52.9%, drayage hours by 26.7%, emissions and fuel use by 41.9% to 45.4%, and cost by 29.3%.

In other words, the additional 20 miles (one way) to shippers and receivers accounted for over half the drayage miles, 26.7% of the hours, 41.9% to 45.4% of the emissions and fuel, and 29.3% of the cost.

Table 12–1 compares the drayage hours by category for a 25-mile scope and a 5-mile scope. In addition to the overall reduction in total and average hours, the proportions of idle, creep,

Activity Group	Number of Trips	Distance (Miles)	Total (hours)
Marine Terminal	2,917,414	17,012,538	2,533,308
Inter-Terminal	5,714	22,857	878
Off-Dock Rail Terminal	346,909	1,367,673	164,735
Container Depot	69,917	154,697	27,401
Shippers & Receivers	1,811,250	45,589,163	2,136,895
Crosstown Trips	426,588	4,267,065	340,110
Other Port Trucks	-	-	-
Net Total*	**3,826,235**	**68,413,994**	**5,203,327**

*Subtotals and total are corrected to remove double-counting of marine terminal trips.

Figure 12–3. Marine terminal vs. shipper/receiver activity.

SmartWay DrayFLEET Version 1.0 Primary Inputs & Outputs

DrayFLEET Version 1.0E of 06/26/2008

Primary Inputs	Default	Scenario
Port		
Calendar Year	2007	2007
Annual TEU	2,000,000	2,000,000
Average TEU per Container	1.75	1.75
Inbound Share	50%	50%
Inbound Empty Share	5%	5%
Outbound Empty Share	25%	25%
Rail Intermodal Share	25%	25%
Marine Terminals		
Average Inbound Gate Queue Minutes	15	15
Average Marine Terminal Min. per Transaction	30	30
Rail Terminals		
Weighted Average Miles from Port	5	5
Average Inbound Gate Queue Minutes	5	5
Average Rail Yard Min. per Transaction	15	15
Container Depots		
Weighted Average Miles from Port	2	2
Share of Empties Stored at Depots	10%	10%
Container Shippers/Receivers		
Weighted Average Miles from Port	25	5
Weighted Average Crosstown Trip Miles	10	10
Cost Factors		
Average Drayage Labor Cost per Hour	$ 12.00	$ 12.00
Average Diesel Fuel Price per Gallon	$ 4.00	$ 4.00

Initiative Inputs	Default	Scenario
Port/Terminal Initiatives		
Stacked Terminal (% stacked)	0%	0%
On-Dock Rail (% of rail on-dock)	0%	0%
Automated Gates (% of gate transactions)	0%	0%
Extended Gate Hours (% off-peak, 50% max)	0%	0%
Container Info System (% used)	0%	0%
Virtual Container Yard (% available)	0%	0%
Neutral Chassis Pool (% used)	0%	0%

Port	Generic
Terminal(s)	All
Scenario	Five-mile versus 25-mile Limits
Date	6/26/2008

Activity Outputs	Default	Scenario	Change	% Change
Annual Activity				
Number of Drayage Trip Legs	3,826,235	3,826,235	0	0.0%
Drayage Trip Legs per Container	3.3	3.3	0.0	0.0%
Total Drayage VMT	68,413,994	32,188,994	-36,225,000	-52.9%
Drayage VMT per Container	59.9	28.2	-31.7	-52.9%
Fleet Required (FTE Tractors)	1,756	1,286	-469	-26.7%
Annual Duty Cycle Totals				
Idle Hours	1,957,060	1,725,478	-231,582	-11.8%
Creep Hours	1,089,182	991,532	-97,651	-9.0%
Transient Hours	597,318	339,489	-257,828	-43.2%
Cruise Hours	1,559,766	755,790	-803,977	-51.5%
Total Drayage Hours	5,203,327	3,812,289	-1,391,038	-26.7%
Drayage Hours per Container	4.6	3.3	-1.2	-26.7%

Emissions Outputs	Default	Scenario	Change	% Change
Pollutant (annual tons)				
HC	55	32	-23.34	-42.3%
CO	311	181	-130.12	-41.9%
NOx	1,154	637	-517.58	-44.8%
PM_{10}	38	21	-17.27	-45.4%
$PM_{2.5}$	32	18	-14.60	-45.4%
CO_2	145,037	79,582	-65,455	-45.1%
Fuel Use and Total Cost				
Fuel - Gallons	12,963,067	7,112,838	-5,850,228.3	-45.1%
Total Drayage Cost	$ 185,045,398	$ 130,800,961	$ (54,244,438)	-29.3%
Drayage Cost per Container	$ 162	$ 114	$ (47)	-29.3%

Figure 12–4. Five-Mile scenario versus 25-mile default.

transient, and cruise hours shift noticeably. With a 25-mile scope, 30% of the hours are spent in cruise mode. Activity within 5 miles of the port, however, is dominated by idling at 45% of the total hours.

Initiatives and Technology Impacts

Modeling the emissions impacts of port and terminal management initiatives (such as neutral chassis pools and automated gates) was a major reason for developing DrayFLEET. Likewise, DrayFLEET is intended to estimate the impacts of truck and engine technology such as diesel particulate filters or idling controls.

The EPA SmartWay Program offers freight carriers technical and financial information on a range of truck and engine technologies and practices designed to conserve fuel and reduce emissions. Many of the applicable options have been built into DrayFLEET, as shown in Figure 12–5.

Table 12–1. Scope comparison.

Category	Default - 25-Mile Trips		Port Vicinity - 5-Mile Trips	
Idle Hours	1,957,060	38%	1,725,478	45%
Creep Hours	1,089,182	21%	991,532	26%
Transient Hours	597,318	11%	339,489	9%
Cruise Hours	1,559,766	30%	755,790	20%
Total Drayage Hours	**5,203,327**	**100%**	**3,812,289**	**100%**
Drayage Hours per Container	**4.6**		**3.3**	

Technology Retrofits		
☐ Particulate Filter/Trap	% of eligible fleet retrofit	50%
☐ Oxidation Catalyst	% of eligible fleet retrofit	50%
☐ Flow-Through Filter	% of eligible fleet retrofit	50%
Idle Reduction		
☐ Idling Control Strategies	% reduction in idle	50%
Fuel Conservation		
☐ Single-Wide Tires	% of fleet	50%
☐ Automatic Tire Inflation	% of fleet	50%
☐ Tare Weight Reduction	% of fleet	50%
	lbs of weight saved	2,000
☐ Low Friction Engine Lubricant	% of fleet	50%
☐ Low Friction Drive Train Lubricant	% of fleet	50%
☐ Direct Drivetrain	% of fleet	50%
☐ Single Axle Drive (vs. Dual Axle)	% of fleet	50%
☐ Speed Management Policy (55 mph)	% of fleet	50%

Figure 12–5. DrayFLEET technology and strategy options.

These measures have different impacts on drayage emissions and fuel use, depending on which combination of options is applied and how widely they are implemented across the fleet.

Data Sources

The primary sources for DrayFLEET Model input data are the port authority, the marine terminals, and the other activity centers (off-dock rail terminals, container depots, and shipper/receiver facilities).

Port Data

Port authorities ordinarily track the inbound (import) and outbound (export) volumes of loaded and empty containers. These data are almost always kept in TEU, but also may be available in containers. Data on empty container flows may not be as readily available and sometimes may not be as accurate.

Marine Terminal Data

Container terminal operating systems collect information on gate activity. Movement of loaded containers, empty containers, and bare chassis to and from the marine terminals tends to be well documented, but some reconciliation between interchange documentation and gate records may be required. In practice, the accuracy and accessibility of gate information will vary with the accuracy of inputs, the rigor with which the system is maintained, and the experience of those accessing the data.

Rail Terminal Data

Likewise, comprehensive data on gate transactions is kept by rail intermodal terminal operators and their systems, of which OASIS is a leading example. Although rail terminals are owned and ultimately controlled by the railroads, they are ordinarily operated by contractors. Clerical functions at the gates and any automated systems are supervised by the contractor, as is data input. Although gate transaction data might be obtained through a railroad representative, issues of accuracy, completeness, and interpretation may need to involve the contract operators.

Container Depot Data

Most container depots are privately operated, either by one of a few regional or national companies, or by local entrepreneurs. They store containers for ocean carriers and leasing companies. Depots also maintain and repair containers, but the activity model does not distinguish trips for repair or maintenance from trips for storage. Container depots keep electronic records of their transactions, but as private companies, their cooperation in providing data is strictly voluntary.

Shipper and Receiver Data

Obtaining reliable distance and volume information for shipper (export) and receiver (import) trips can be a considerable challenge. The actual locations and container volumes are known only to the shippers and consignees themselves, and perhaps to the drayage firms that serve them. Port marketing and sales departments can be a source of insight on the actual locations of port customers and for customer contact information.

Street Turn and Crosstown Data

Ordinarily, there is no organization that keeps data on street turns and crosstown trips, so estimates are required. Two factors are at stake: the frequency of street turns (reuse of import containers for export loads) and other crosstown trips, and the distance commonly traveled. In both instances, major drayage firms would be the best sources for estimates.

National Drayage Cost and Emissions Estimates

In NCFRP Project 14, the study team used the EPA SmartWay DrayFLEET Model to estimate vehicle activity associated with port drayage, its cost, and resulting emissions. In 2008, U.S. ports handled a total of 22,597,601 TEU in about 13 million individual containers. The DrayFLEET Model was used to estimate the operational, financial, and environmental costs of container drayage at the nation's ports.

The DrayFLEET Model was configured with a weighted average drayage distance of 5 miles and no waiting time at customer locations. These modifications effectively restrict the model to a 5-mile working range around the port terminals. This step was necessary to focus the analysis on differences in terminal and port-area operations rather than to have the potential improvements observed by over-the-road operations.

The 13 million containers required an estimated 41.6 million drayage trip legs, an average of 3.2 per container. Those trips required an estimated 39.1 million driver and tractor hours to cover 326 million miles.

The model estimates that 45% of the drayage hours in the vicinity of the ports were spent idling, which is generally consistent with most driver survey results. About 26% of the hours were spent in "creep" mode, essentially low-speed, stop-and-go operation typical of queuing or in-terminal operation. This allocation highlights the amount of time—nearly 18 million hours annually—that drayage drivers and their tractors spend idling. In those operating hours, port drayage tractors burned an estimated 69.9 million gallons of diesel fuel and emitted 782,613 tons of CO_2, the major greenhouse gas impact (see Table 12–2).

Table 12–2. DrayFLEET modeling results.

Scenario		Hours (million)	Fuel (million gal.)	CO_2 (tons)	NO_x (tons)	PM 2.5 (tons)	Cost (million)
2008 National Default		**39.1**	**69.9**	**782,613**	**7,678**	**149**	**$1,440.00**
30 vs. 40 Minute Terminal Time		(3.2)	(1.4)	(15,652)	(160)	(3)	$(79)
	Change	-8.1%	-2.0%	-2.0%	-2.1%	-1.9%	-5.5%
10 vs. 20 Minute Queue Time		(2.7)	(2.0)	(21,913)	(225)	(4)	$(69)
	Change	-6.8%	-2.8%	-2.8%	-2.9%	-2.7%	-4.8%
3% vs. 5% Trouble Tickets		(0.3)	(0.1)	(1,632)	(17)	(0)	$(8)
	Change	-0.8%	-0.2%	-0.2%	-0.2%	-0.2%	-0.5%
0% vs. 5% Trouble Tickets		(0.8)	(0.3)	(3,913)	(42)	(1)	$(20)
	Change	-2.0%	-0.5%	-0.5%	-0.5%	-0.5%	-1.4%
Idling Control - 50%		-	(5.9)	(65,739)	(450)	(8)	$(17)
	Change	0.0%	-8.4%	-8.4%	-5.9%	-5.4%	-1.2%
100% vs. 20% Neutral Pools		(0.8)	(0.3)	(3,913)	(42)	(1)	$(20)
	Change	-2.0%	-0.5%	-0.5%	-0.6%	-0.5%	-1.4%
Trucker-Supplied Chassis		(6.1)	(4.4)	(49,305)	(503)	(9)	$(137)
	Change	-15.6%	-6.3%	-6.3%	-6.6%	-6.1%	-9.5%
Combined Strategies		**(14.5)**	**(9.9)**	**(111,050)**	**(979)**	**(18)**	**$(202)**
	Change	**-37.1%**	**-14.2%**	**-14.2%**	**-12.8%**	**-11.8%**	**-14.0%**

As Table 12–2 shows, those tractors emitted an estimated 7,678 tons of NO_x and 149 tons of $PM_{2.5}$, as well as other criteria pollutants.

The estimated total port-area drayage cost was $1.44 billion, an average of about $112 per container. That total included about $210 million in fuel costs at $3 per gallon, which accounted for 4.6% of the total cost.

Impacts of Drayage Bottlenecks

DrayFLEET can be used to estimate the impacts of bottlenecks and sources of delay identified in the study. As an illustration, Table 12–2 also summarizes the results of national scenario estimates made in the course of NCFRP Project 14.

Terminal and Queue Time Reduction

The default national model was configured with a 60-minute average port turn time divided into 20 minutes of queuing outside the gate and 40 minutes inside the terminal. Reduction of the average terminal time from 40 minutes to 30 minutes would reduce the total time required by about 3 million hours (8.1%), and the fuel burned by about 1 million gallons (2.1%). CO_2 emissions would also drop by 2.0%. NO_x would drop by 160 tons (2.09%) and PM 2.5 by 3 tons (1.9%). The annual cost savings would be about $79 million.

If the average queue time were reduced from 20 minutes to 10 minutes, the impacts would be similar (Table 12–2), although the fuel and emissions savings would be greater due to the greater reduction in the relatively inefficient and "dirty" stop-and-go queuing operations.

If both the terminal time and the queue time were reduced by 10 minutes the impacts would be additive.

Trouble Ticket Reduction

In NCFRP Project 14, the study team found that experienced draymen appear to average about 3% trouble tickets (exceptions), although the overall average was 5%. Reducing the incidence of trouble tickets from 5% to 3% would save about 300,000 hours of drayage time, 100,000 gallons of fuel, 17 tons of NO_x, and $8 million dollars in port-area drayage costs.

If trouble tickets could be completely eliminated (0%), the savings would be greater yet: 800,000 drayage hours, 300,000 gallons of fuel, 42 tons of NO_x, 1 ton of PM 2.5, and $20 million. These potential savings are therefore the estimated costs of trouble tickets.

Idling

The estimated 46% of drayage time spent idling, which accounts for nearly 18 million hours nationwide, suggests large potential benefits from idling controls or hybrid truck tractors that would neither burn fuel nor emit pollutants when they were not moving. If the tractor engines could be turned off for half of the time they are now estimated to be idling, yearly fuel use would drop by 5.9 million gallons. Greenhouse gasses (CO_2) would be reduced by over 65,000 tons, NO_x would decline by 450 annual tons, and PM 2.5 would decline by 8 tons in port areas. The fuel saving would reduce drayage cost by about $17 million annually. The hours required would not decline, but for half the 18 million idling hours, the engines would be off.

Chassis Logistics

The EPA SmartWay Program has identified chassis pooling as a promising strategy for improving drayage efficiency and reducing emissions. The DrayFLEET modeling bears out this conclusion. With an assumed 50% of the containers being stacked in the terminals, raising the default 20% usage of neutral chassis pools to 100% usage yielded almost exactly the same benefits as eliminating trouble tickets (Table 12–2). The benefits of neutral chassis pools show up in the model mostly as reduced chassis search time.

A shift to trucker-supplied chassis yielded the greatest benefits of the individual scenarios shown in Table 12–2. Modeling a trucker-supplied chassis system entailed the following:

- Raising the share of containers stacked from 50% to 100%,
- Eliminating chassis search time and bare chassis drop-off time,
- Reducing overall in-terminal time by 10 minutes per move,
- Reducing average gate transaction times from 5 minutes to 3 minutes,
- Reducing average queue times from 20 minutes to 15 minutes, and
- Adding $2 per move (about $6 per day) to drayage costs to account for truckers' chassis supply costs.

Although these modeling changes are necessarily inexact approximations of an emerging system, they indicate the kinds of pervasive changes that can be expected.

The estimated benefits of trucker-supplied chassis include an annual savings of over 6 million hours of driver and tractor time, over 4 million gallons of fuel, and $137 million in drayage costs. CO_2 emissions would decline by an estimated 49,305 tons. Port-area NO_x would decline by an estimated 503 tons, and PM 2.5 by 9 tons.

Combined Impacts and Benefits

Combining all of the scenarios yields an estimate of the improvements possible if queuing were to be minimized, trouble tickets eliminated, idling control implemented on half the fleet, and the transition to trucker-supplied chassis completed. As Table 12–2 indicates, the benefits would be substantial and indicate the value of progress toward drayage bottleneck solutions as follows:

- A 37.1% reduction in total hours—14.5 million hours of driver and tractor time annually,
- A 14.2% reduction in fuel use—an annual savings of nearly 10 million gallons of diesel fuel,

- A 14.2% reduction in CO_2,
- A 12.8% and 11.8% reduction in NO_x and PM 2.5, respectively and
- A 14.0% annual cost savings—over $200 million.

It is likely that efficiency improvements on this scale would have additional benefits not captured in the DrayFLEET Model. For example, there probably would be an opportunity to retire the oldest, least efficient, and most polluting drayage tractors. It is likely that marine terminal operators would realize associated savings in labor and CY operations, as well as gaining capacity by freeing up land presently being used to store chassis.

Implications

The cost and emissions estimates derived from DrayFLEET indicate the magnitude of the drayage issue and the value of potential solutions, together or separately. The United States has made tremendous progress in reducing vehicular emissions, but further progress has become increasingly difficult and costly. Port communities face serious technical, economic, and political challenges in attempting to reduce or control the growth of congestion and emissions from port drayage. The estimates derived for this study indicate the potential scope of improvement achievable through process improvement, reduction of exceptions, and a smooth transition to driver-supplied chassis.

Each port area has a different pattern and volume of drayage options, and thus a different potential for improvement through the measures identified in this guidebook. DrayFLEET can be used in local and regional planning efforts to determine the following:

- The starting point for port-area and regional drayage activity, cost, and emissions (although DrayFLEET is not a substitute for a complete emissions inventory);
- The impact of local practices, bottlenecks, and delays on costs and emissions; and
- The potential VMT, cost, fuel, labor, time, and emissions benefits of potential drayage efficiency improvements.

DrayFLEET (or an equivalent model) can therefore become a valuable tool in investigating and comparing possible solutions and establishing their value to all concerned.

The critical factor in using DrayFLEET for this purpose is realism, the close correspondence between model inputs and relationships and actual truck and terminal operations. Time invested up front to obtain accurate input data and to make the appropriate model inputs and adjustments yield dividends in credibility within the port and drayage community.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation