Assessing near-dock rail loading and offloading procedures at the Port of LA/LB for application to a container conveyor to ICTFs

Final Report

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Abstract

The objective of this short-term monitoring project was to produce a "first-order" metric displaying the range of container near-dock rail loading capacities for various types of equipment and procedures presently used at the Ports of Los Angeles/Long Beach. The application of the general metric will be to evaluate recently proposed container conveyor systems as well as possible expansion of near-dock rail at the Ports. In addition to load/off-load times, labor requirements, area involved, and impacts on other terminal processes during load/unload were evaluated. Load/unload capacities—depending on approach—were measured to be as low as 10 containers/hour and as high as 65 containers/hour with typical capacities in the neighborhood of 40 containers/hour; sufficient for loading over 800 containers/day (two crews operating two shifts) at a single terminal. A longer, more detailed study would have produced upper and lower confidence bounds to the reported numbers. Actual costs of a lift will also vary with process and equipment, but are around $100. Specific costs cannot be documented by approach because of the competitive value of this data to terminal economics.

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Disclosure

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Acknowledgments

The authors acknowledge the helpful assistance of both Jeremy Ford of the APM (Maersk) Terminal and Mike Shanks of the ITS Terminal in arranging visits to their facilities and providing helpful suggestions in colleting data on various load/unload processes. The authors also acknowledge the expertise of Bob Bey of Cal-Lift concerning the operation and capabilities of the many forms of container load/unload equipment.

1 Introduction

The current equipment and process for loading a single container onto near-dock rail is the closest terminal process to that required for a conveyor carriage fixed to a guideway. Thus, as explained further in Section 2, a metric of near-dock, rail load/off-load equipment and their process characteristics is needed to facilitate a clearer understanding of container conveyor load/unload capacity at a terminal. Section 3 describes qualifications and limitations to obtaining container transfer data in a terminal environment. After describing the uncertainties in data acquisition, the results of the study are summarized. Section 4 presents the detailed results of the study, the performance of which is outlined below.

Two fundamental types of container handling equipment were evaluated: (1) top-loaders, and (2) wheeled cranes. Quantification of performance parameters such as lifts per hour, crew size and labor grade, and required three dimensional (3D) range of motion of a lift in both area and height were determined for specific models of both types of equipment. In addition, impacts on other terminal processes during an equipment load were qualitatively evaluated.

Two Terminals were visited on-site: International Transportation Services (ITS) and Maersk. Equipment movement was recorded and documented. Three locations were observed from off-site: ITS, Long Beach Container Terminal (LBCT), and the Burlington Northern Santa Fe (BNSF) Hobart Intermodal Container Transfer Facility (ICTF). The off-site observations were performed to remove any influence that our presence would have on the job performance of the crews, and to compare on-site and off-site measurements of the same process. By prior agreement, the name of the terminal where each specific process data accumulation occurred will not be delineated to protect their economic interests.

Each of the three (3) terminals and one Intermodal Container Transfer Facility (ICTF) had their container load and unload movements recorded for total timing and throughput. Different crews and equipment were observed. Since periods of observation varied, the time required for touch to touch (first container handling equipment contacting the container to when the handling equipment released the container) operation was averaged and that average was used to estimate how many containers would have been moved in an hour.

Twenty-one (21) crews where observed using seven (7) different equipment operations. The manning or crew sizes are specified by the Pacific Coast Longshore Contract Document (commonly referred to as the “PCLCD”); data from that organization was used for this study’s work crew and area of operation for each process. Observations determined no deviation from these rules, other than an occasional variance favoring additional safety.

The terminals where observed both on site and off-site; in both instances there was no interaction between the working crew and those making the observations. This was done to prevent any influence on the work flow.

2 ECCO Implementation and the Need for a Terminal Process Survey

Utilizing the Electric Cargo Conveyor (ECCO) system for eliminating truck drayage at a congested port requires load and unload processes capable of meeting the throughput capabilities of the system. Present indications are that the ECCO can move 5000 containers a day (*Conceptual Design Study For The Electric Cargo Conveyor (Ecco) System*) from the port to a near- or off-dock rail intermodal. The question has naturally arisen as to how to load and unload that number of containers onto and off of such a system. Since many container terminals combine to feed the ECCO system, no one terminal is required to load and unload the full capacity of the ECCO. Thus the many terminals feeding the ECCO can likely use similar load and unload processes as described and quantified in this report. Figure 1 shows a possible implementation of conventional rail loading approaches to an ECCO loading process. A metric of existing rail load/unload parameters will provide an excellent starting point for predicting the operational and economic impact of an ECCO system replacement of truck drayage.

Figure 1 ECCO at terminal application

The stress to load and unload the full ECCO system capacity is at the ECCO-to-rail intermodal terminus where containers from many terminals all feed into the intermodal facility for transfer to transcontinental rail. For this application, the College of Engineering anticipates the use of the much higher throughput CCDoTT GRAIL (Grid Rail) system that was developed for USTRANSCOM nearly a decade ago. This system with its self-sorting ability is ideal for the container throughputs of which the ECCO is capable. Such a GRAIL system is a likely terminus for the ECCO at the intermodal end of a system to replace truck drayage at the terminals, and is the subject of another study funded by the Office of Naval Research via CCDoTT.

3 Terminal Load/Unload Results Summary and Data Qualifications

3.1 Qualification of data collection

Variation in both human factors and equipment capability in the wide variety of terminal processes makes quantitative evaluation difficult; Sine basic assumptions must be made to facilitate analysis. Therefore, container transfer time herein represents approximate terminal throughput. Not all crews work at the same speed or have the same experience, so variations on the number of containers handled per hour was expected and encountered. A secondary factor related to how many containers can be handled per hour determined how many supporting vehicles were assigned to each movement. For example, a crew can only move containers as fast as the slowest vehicle allows; a crew had a steady and consistent line of vehicles to load or unload moves more containers than a crew who had to wait for vehicles.

The total time required to move a container was determined from two measurements. First, “touch to touch” is the time required for a crew with an unlimited source of containers, i.e., there was always a vehicle ready to be worked on. Second, “between lift ” is the time that the crew did not do any work because they were waiting for (1) a container to arrive, (2) for vehicle to place the container on, or (3) for the equipment to be repositioned for the next move. The addition of “touch to touch” and “between lift” times was used to calculate the actual time required for one load//unload cycle, which was used in turn to estimate the entire throughput of a one hour time period.

A more detailed study would include multiple observations of the same crews and processes. These long term observations may discover variations in output due to crew interactions, weather patterns, equipment malfunctions and other variations that have not been taken into account in the present study. The inclusion of such factors is beyond the scope of this project.

3.2 Summary of Results

The process approach is described in the following sections. A photograph taken of the process from the measurement perspective is provided for quick understanding of the process description. Tables summarizing the results of time in motion measurements and labor crew requirements including quoted requirements from ILWU documentation are also provided. Raw data sheets for each process approach and measurement perspective are in appendix B. The aggregated and tabulated measurements from which each process summary table was generated are in Appendix A. Diagrams are from ILWU Pacific Coast marine safety Code book.

A brief explanation of the measurements as specified in the data tables is described as follows: The *number of observations* refer to how many different crews were timed performing a certain task; e.g., for the tire gantry crane a total of five crews were timed for (a varied amount of time) and their average throughput was used to estimate the possible container movement for a one hour time frame.

The *average lift time* refers to the interval between the moment the container is touched by either a crane or a toploader and the moment that it is released on the receiving vehicle. This measurement indicates the quantity of containers that could be moved if there were no restrictions on the process.

The *average time between lifts is* the time the handling equipment waits for a container or a receiving vehicle. This time varies depending on how many vehicles are supporting the load, unload process. The more vehicles involved, the shorter the time between lifts, therefore the higher the hourly throughput.

Containers processed in x amount of minutes is the resultant of the addition the of the throughput of all the crews loading or unloading.

The *predicted containers per hour* is the direct calculation of taking the number of containers processed in *X* minutes, dividing by the amount of minutes then multiplying by 60 to obtain the predicted number of containers that could be processed if all the variables were to stay the same.

4 Terminal Survey Results

4.1 Tire gantry crane to drayage truck from storage

Grounded containers are loaded from grounded storage to drayage trucks, while the container movement can be observed and tabulated, the final destination of the container can only be surmise that since the container is leaving the port on a drayage truck that the container is an incoming international container bound for either local or national distribution. Since drayage trucks are normally only used when the container will leave the terminal.

i) Measurement Approach: Time per container move was measured from when the crane connected to the container until the time the container was placed and released on the drayage truck. The average time between lifts was attributed to either repositioning the equipment of waiting for drayage truck to arrive at the loading position.
The time between lifts needs to be added to the loading time to obtain the total amount of time needed to move containers.

Figure 2 Tire gantry crane to drayage truck from storage

ii) Time in Motion Results

Tire gantry crane to drayage truck from storage	
Number of observations	*5*
average lift time	*0:56*
average time between lifts	*2:13*
containers processed in 48:14 Min.	*18*
Predicted containers per hour	*22*

Table 1 Rubber Tired gantry crane to drayage truck from storage

Minimum crew required	*Quantity*	*Min.*	*Actual*
foreman supervises the whole crew	*1*	*1*	*1/10*
Chief Clerk	*1*	*1*	*1/15 – 1/20*
floor runner per gang find the containers to be unloaded or loaded	*2*	*1*	*1*
dockman/pinman puts on // takes off cones	*2*	*1*	*1*
driver take containers to offsite	*1*	*0*	*0*
Transtainer operators	*2*	*2*	*2*

Table 2 crew required Rubber Tired gantry Crane

iii) This is a brief explanation of the actual manning category

1. There is one (1) Foreman for all the crews in the Container Yard (CY) – this is a CY-related category only. As a general rule though, there is one (1) foreman per ten (10) lifting equipment units in operation in the CY.
2. There is only one (1) Chief Clerk for all CY operations

3. There is only one (1) floor runner per lifting unit – no exceptions. However, in certain terminal with active Global Positioning Systems (GPS), Radio-frequency identification (RFID) and Optical Character Recognition (OCR) and Next Move capability, there are no clerks at all working with each lifting unit. Most terminals in Los Angeles/Long Beach (LA/LB) will achieve this status by early 2008.
4. There is only one (1) dockman / pinman per transtainer (rubber-tired gantry crane) lifting unit in the yard.
5. The "driver to take containers off-site" is not an ILWU manning category. This category is over-the-road truckers calling the terminal as owner-operators or employees of independent non-union (mostly) trucking companies. Their cost or manning is not that of the ILWU.
6. Each transtainer requires two (2) operators, no exceptions.

iv) Minimum space requirements: Rubber Tired Gantry (RTG) Crane Operations: When hoisting containers to or from trailers, chassis or bombcarts, the stacks adjacent to the truck lane shall not exceed two high. (see Figure 3). Spacing between trailers, chassis or bombcarts has no minimum requirement.

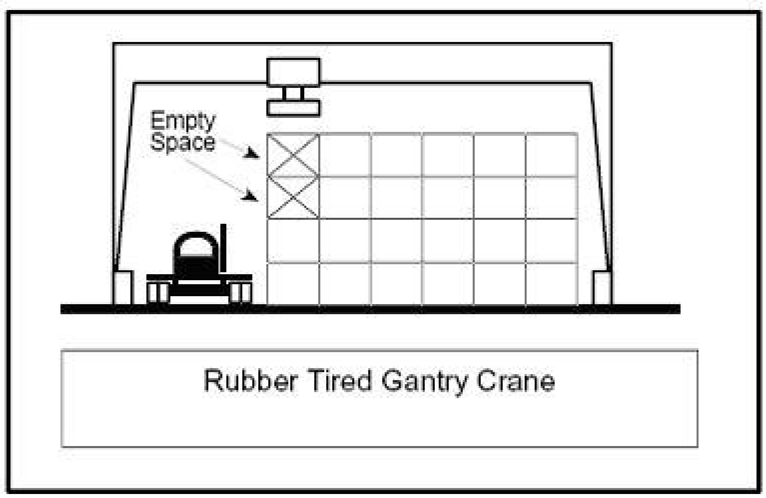

Figure 3 Rubber Tired Gantry Crane

4.2 Toploader loading double stacked train from bombcarts

The Containers were obtained from grounded storage, or brought over directly after being unloaded from a ship. Since bombcarts were used for this operation, then it is surmised that the container was on terminal grounds before being loaded to the train. Since trains are only used for long haul operations, then it is concluded that the containers will be traveling to the continental US instead of being used for local deliveries.

i) Measurement Approach: The average lift time was measured when the toploader contacted the container to when the toploader released the container at its new position. The time between lifts was attributed to repositioning the equipment or waiting to for a bombcart to arrive.

Figure 4 Toploader loading double stacked train from bombcarts

ii) Time in Motion Results

Toploader loading double stacked train from bombcarts	
Number of observations	*4*
average lift time	*0:45*
average time between lifts	*1:15*
containers processed in 42:07 Min.	*35*
Predicted containers per hour	*49*

Table 3 Toploader loading double stacked train from bombcarts

Minimum crew required	***Quantity***	***Min.***	***Actual***
foreman supervises the whole crew	***1***	***1***	***1/10***
Chief Clerk	***1***	***1***	***1/15 – 1/20***
clerk per gang	***1***	***0***	***0***
floor runner per gang find the containers to be unloaded or loaded	***1***	***1***	***0 / 1***
UTR driver take containers to from storage	***5***	***1***	***7/8***
Toploader operator	***1***	***1***	***1***

Table 4 Crew Requirements Toploader from Grounded storage to/from double stacked train

iii) This is a brief explanation of the actual manning category

1. There is one (1) Foreman for all the crews in the CY – this is a CY-related category only. As a general rule though, there is one (1) foreman per ten (10) lifting equipment units in operation in the CY. This is a CY operation, even though it operates in conjunction with an in-progress on-dock DST operation.
2. There is only one (1) Chief Clerk for all CY operations – no exceptions. The above range displays potential number of lifting units per CY handle by a single Chief Clerk.
3. There is only one (1) floor runner per lifting unit – no exceptions. However, in certain terminal with active GPS, RFID and OCR and Next Move capability, there are no clerks at all working with each lifting unit. Most terminals in LA/LB will achieve this status by early 2008.
4. The "driver to take containers off-site" is not a single driver. There are normally 7 / 8 ILWU UTR drivers assigned to work CY operations in conjunction with on-dock DST operations. There may be more in many instances, depending upon travel distances, and on occasion there may be less. Generally, the actual usage minimum is five (5) with general maximum of twelve (12) in practice. Please be reminded that these UTR drivers have been assigned in the report as operationally functioning within the CY portion of the operations and this is in error. All these UTR drivers are thus removed from this category and will be placed within the DST handling operation portion of the categorized operating modes by equipment handling type.

   Each tophandler requires one (1) operator, no exceptions.

iv) Minimum space requirements: Top loaders have antenna which requires a vertical clearance of 60'. The height of the antenna is 55'. Clearance is 60'. Hostlers and tractors pulling trailers, chassis or bomb carts being loaded/unloaded by Top Handlers, Side Handlers or Reach Stackers must stay back a minimum of one full container length from the bay being worked until the hoisting vehicle is ready to service them (Figure 5).

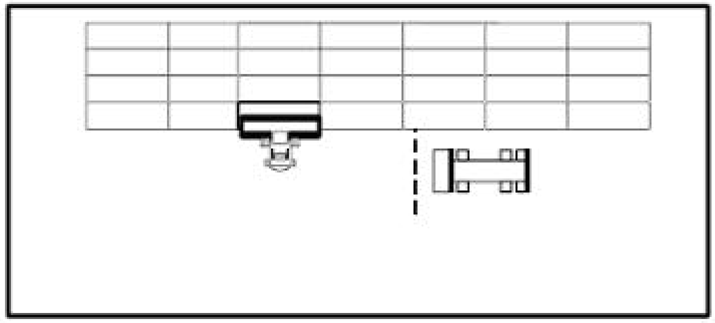

Figure 5 Distances between Hostlers and Top Loaders

4.3 Toploader from double stacked train to bombcart

Incoming containers are unloaded to bombcarts surmising that since they are being loaded on bombcarts that the container is destined for either grounded storage or being directly loaded to a ship. The bombcarts are only used on terminal property therefore the container will be not be leaving the terminal unless it is reloaded on a different type of vehicle. The incoming trains are bringing in export containers.

i) ***Measurement Approach:*** The average lift time was measured when the toploader contacted the container to when the toploader released the container at its new position. The time between lifts was attributed to repositioning the equipment or waiting to for a bombcart to arrive.

Figure 6 Toploader from double stacked train to bombcart

ii) Time in Motion Results

Toploader from double stacked train to bombcart	
Number of observations	***1***
average lift time	***0:37***
average time between lifts	***1:12***
containers processed in 3:07 Min.	***3***
Predicted containers per hour	***57***

Table 5 Toploader from double stacked train to bombcart

Minimum crew required	*Quantity*	*Min.*	*Actual*
foreman supervises the whole crew	1	1	1 / 2 - 1
Chief Clerk	1	1	1 / 2 - 1
clerk per gang	1	0	0
floor runner per gang find the containers to be unloaded or loaded	2	1	0 / 1
dockman/pinman puts on // takes off cones	2	2	2
UTR driver take containers to offsite	1	1	7 / 8
Toploader operator	1	1	1

Table 6 Crew requirements: Toploader from double stacked train to bombcart

iii) This is a brief explanation of the actual manning category

1. There is one (1) Foreman for all the gangs handling on-dock DST operations. Thus, this is common, if there are two (2) DST gangs operating, then the Foreman functions over both gangs.
2. There is one (1) Chief Clerk for all the gangs handling on-dock DST operations. Thus, this is common, if there are two (2) DST gangs operating, then the Chief Clerk functions over both gangs.
3. There is only one (1) floor runner per lifting unit – no exceptions. However, in certain terminal with active GPS, RFID and OCR and Next Move capability, there are no clerks at all working with each lifting unit. Most terminals in LA/LB will achieve this status by early 2008.
4. Dockmen/pinmen work against all tophandler DST operations.
5. The "driver to take containers off-site" is not a single driver. There are normally 7 / 8 ILWU UTR drivers assigned to work CY operations in conjunction with on-dock DST operations. There may be more in many instances, depending upon travel distances, and on occasion there may be less. Generally, the actual usage minimum is five (5) with general maximum of twelve (12) in practice. The proper number of UTR drivers have been assigned in the "actual" category above.
6. Each tophandler requires one (1) operator.

7. Additionally, in all cases whereby on-dock shuffling of containers within on-dock DST railyards are completed, ILWU manning must be assigned to handle "TrackMobiles" which are rail mounted (with option switching to tire mounted) car pushers that are designed to push DST cars around the terminal with the ability to switch back and forth between the railed and the wheeled modes. If this is the case per marine terminal, then those terminals are required to employ one (1) TrackMobile driver to operate the machinery. In such instances, additionally a third (3) dockman/coneman is employed to provide internal terminal rail switching capabilities just ahead of the TrackMobile car pusher. Thus, most commonly two (2) additional ILWU manning are required against DST operations with internal switching capabilities. This is perhaps 50% of the terminals on the U.S. West Coast.

iv*) *Minimum space requirements: Top loaders have antenna which requires a vertical clearance of 60'. The height of the antenna is 55'. Clearance is 60'. Hostlers and tractors pulling trailers, chassis or bomb carts being loaded/unloaded by Top Handlers, Side Handlers or Reach Stackers must stay back a minimum of one full container length from the bay being worked until the hoisting vehicle is ready to service them (See Figure 7).

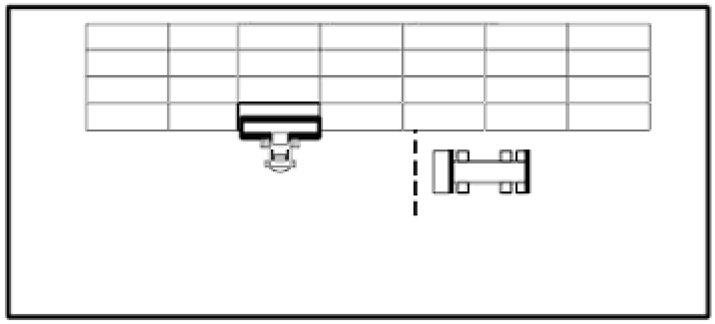

Figure 7 Distances between Hostlers and Top Loaders

4.4 Toploader from storage to bombcart

The bombcarts are only used on terminal property therefore the container will be not be leaving the terminal unless it is reloaded on a different type of vehicle. Therefore this containers were either loaded on a ship, a train or moved somewhere else on terminal as part of grounded storage.

i) ***Measurement Approach*:** The average lift time was measured when the toploader contacted the container to when the toploader released the container at its new position. The time between lifts was attributed to repositioning the equipment or waiting to for a bombcart to arrive.

Figure 8 Toploader from storage to bombcart

ii) ***Time in Motion Results***

Toploader from storage to bombcart	
Number of observations	***1***
average lift time	***0:39***
average time between lifts	***0:31***
containers processed in 1:50 Min	***2***
Predicted containers per hour	***65***

Table 7 Toploader from storage to bombcart

iii) Minimum space requirements: For Top loaders have antenna which requires a vertical clearance of 60'. The height of the antenna is 55'. Clearance is 60'. Top Handlers, Side Handlers or Reach Stackers when working side by side on the same side of the aisle (See Figure 9) or when working on opposite sides of the same aisle (See Figure 10) shall maintain a minimum separation of one container length between each operation. If the aisle is a minimum of 100 feet wide, back to back operations are permitted (see Figure 11). Top Handler, Side Handler and ReachStacker or RTG operations, containers of different lengths shall not be stowed in the same bay. (Figure 12)

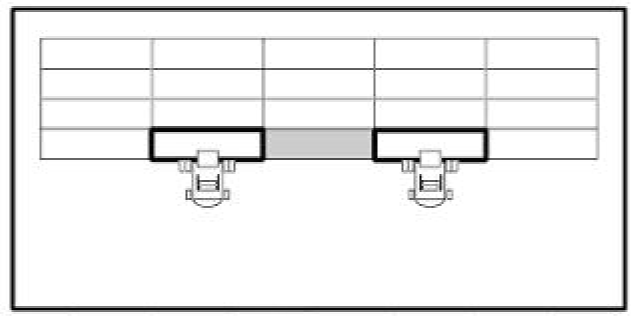

Figure 9 Horizontal Distances between Two Top Loaders

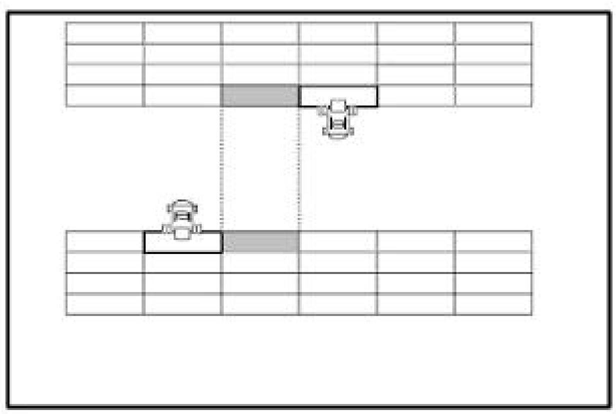

Figure 10 Distances between Two Top Loaders

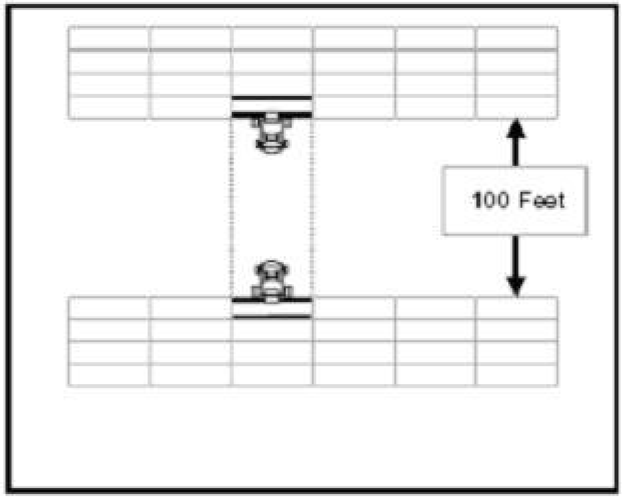

Figure 11 Distances between Hostlers and Top Loaders

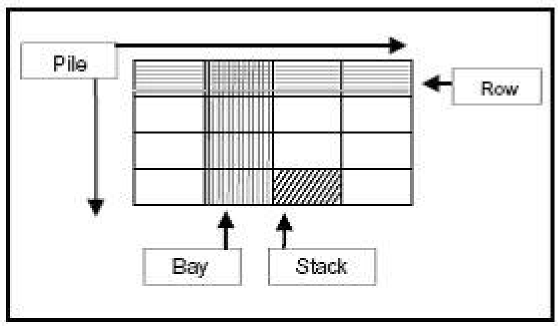

Figure 12 Bay Configurations

4.5 Truck to double stacked train using rail gantry crane

The containers were moved from bombcart to train, since the bombcarts are only used on port property and it is very rare that a ship will be unloaded directly into a train, then it is surmised that the container was in grounded storage. Since trains are usually loaded for intercontinental delivery it is surmised that the containers being loaded are incoming international containers bound for the intercontinental U.S.

i) ***Measurement Approach:*** Time was measured when the crane contacted the container placed it at new position and contacted the second container, thereby returning to its original starting point. The time between lifts is the time required to either reposition the crane or the time required for a bombcart to be positioned in place for handling.

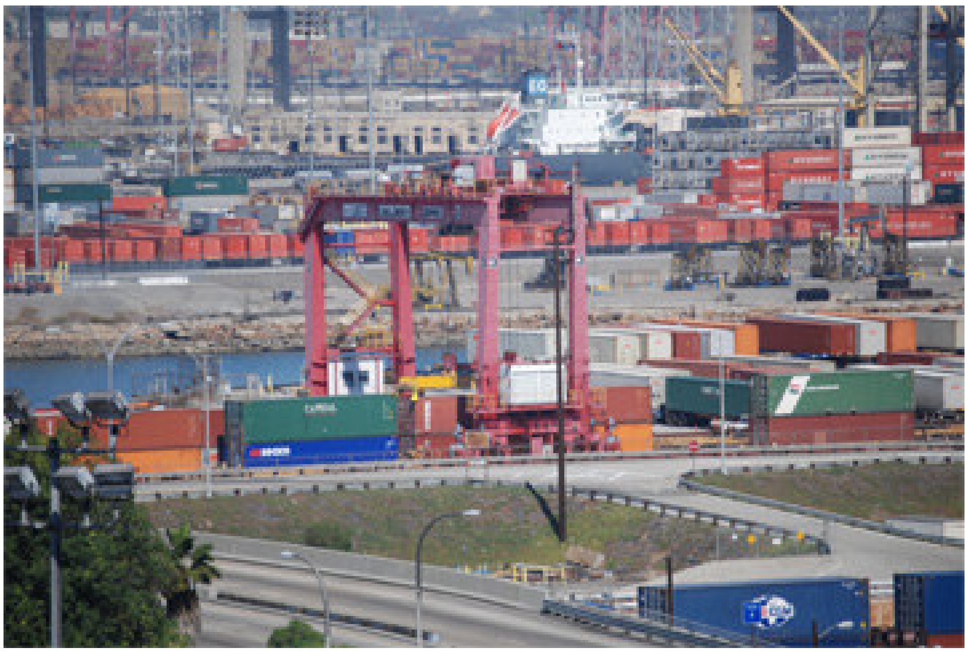

Figure 13 Truck to double stacked train using rail gantry crane

ii) *Time in Motion Results*

Truck to double stacked train using rail gantry crane	
Number of observations	*2*
average lift time	*1:17*
average time between lifts	*6:22*
containers processed in 39:37 Min.	*7*
Predicted containers per hour	*10*

Table 8 Truck to double stacked train using rail gantry crane

Minimum crew required	***Quantity***	***Min.***	***Actual***
foreman supervises the whole crew	***1***	***1***	***1 / 2 - 1***
Chief Clerk	***1***	***1***	***1 / 2 - 1***
floor runner per gang find the containers to be unloaded or loaded	***2***	***1***	***0 / 1***
dockman/pinman puts on // takes off cones	***2***	***2***	***2***
UTR driver take containers to offsite	***1***	***1***	***7 / 8***
Rail gantry crane operator	***2***	***2***	***2***

Table 9 Crew requirements: Truck to double stacked train using rail gantry crane

iii) This is a brief explanation of the actual manning category

1. There is one (1) Foreman for all the gangs handling on-dock DST operations. Thus, this is common, if there are two (2) DST gangs operating, then the Foreman functions over both gangs.
2. There is one (1) Chief Clerk for all the gangs handling on-dock DST operations. Thus, this is common, if there are two (2) DST gangs operating, then the Chief Clerk functions over both gangs.
3. There is only one (1) floor runner per lifting unit – no exceptions. However, in certain terminal with active GPS, RFID and OCR and Next Move capability, there are no clerks at all working with each lifting unit. Most terminals in LA/LB will achieve this status by early 2008.
4. Dockmen/pinmen work against all tophandler DST operations.
5. The "driver to take containers off-site" is not an ILWU manning category. This category is over-the-road truckers calling the terminal as owner-operators or employees of independent non-union (mostly) trucking companies. Their cost or manning is not that of the ILWU.
6. Each Rail gantry crane requires two (2) operators.

iv) Minimum space requirements: Obstructions shall not be placed in the immediate active travel area of rail-mounted shore-based cranes or within three feet (3') of moving or traveling parts which would create an area where a person could be pinned, except this shall not apply to crane legs which travel within three feet (3') of the face of the dock, or where less than three feet (3') of clearance between crane legs and gangways exists. When such condition exists, it shall be called to the attention of the workers and they shall use extreme caution whenever they are in these areas. Where employee access to the backreach area of container cranes.

4.6 Rail gantry crane to double stacked train

The containers were moved from drayage truck to train. Since trains are usually loaded for intercontinental delivery it is surmised that the containers being loaded are either incoming international containers or domestic containers bound for the intercontinental U.S.

i) ***Measurement Approach:*** Time was measured when the crane contacted the container placed it at new position and contacted the second container, thereby returning to its original starting point. The time between lifts is the time required to either reposition the crane or the time required for a drayage truck to be positioned in place for handling.

Figure 14 Rail gantry crane to double stacked train

ii) Time in Motion Results

Rail gantry crane to double stacked train	
Number of observations	***5***
average lift time	***0:41***
average time between lifts	***1:34***
containers processed in 50:21 Min.	***38***
Predicted containers per hour	***45***

Table 10 Rail gantry crane to double stacked train

iii) ***Work Crew Requirements:*** Not a union facility, but work crew appeared to have similar composition as that of a union shop.

iv) ***Minimum space requirements:*** Not a union facility, but work space appeared to have similar composition as that of a union shop.

4.7 Quay gantry crane to bombcart

The containers are being unloaded to bombcarts which surmises that the container will be placed on either on terminal property as grounded storage or be placed on an outgoing train.

i) ***Measurement Approach:*** Time was measured when the crane contacted the container placed it at new position and contacted the second container, thereby returning to its original starting point. Since there was a steady and consistent line of bombcarts there was no time lost to waiting for the bombcarts to be in place.

Figure 15 Quay gantry crane to bombcart

ii) Time in Motion Results

Quay gantry crane to bombcart	
Number of observations	2
average time between container load	1:27
containers processed in 26:54 Min.	20
Predicted containers per hour	44

Table 11 Quay gantry crane to bombcart

Minimum crew required	Quantity	Min.	Actual
foreman supervises the whole crew	1	1	1 / 5 - 1
Chief Clerk	1	1	1 / 5 - 1
clerk per gang	1	1	0 / 1
floor runner per gang find the containers to be unloaded or loaded	2	0	0 / 2
dockman/pinman puts on // takes off cones	2	2	2
Hatch boss per gang tell crane where to put the containers (load)	2	2	2
lashers (first and last shift only) ties or untie containers from ship	4/5	4	4 / 5
UTR driver take containers to offsite	1	1	7 / 8
Quay gantry crane operator	2	2	2

Table 12 Crew requirements: Quay gantry crane to bombcart

iii) This is a brief explanation of the actual manning category

1. There is one (1) Foreman for all the gangs handling each vessel's operations. Thus, this is common, if there are up to six (6) gangs operating per vessel, then the Foreman functions over all such gangs.
2. There is one (1) Chief Clerk for all the gangs handling each vessel's operations. Thus, this is common, if there are up to six (6) gangs operating per vessel, then the Chief Clerk functions over all such gangs.
3. There is only one (1) clerk per vessel gang – no exceptions. However, in certain terminal with active GPS, RFID and OCR and Next Move capability, there are no clerks at all working with each lifting unit. Most terminals in LA/LB will achieve this status by early 2008.
4. There are no (0) floor runners required per vessel gang as a minimum. Most commonly, terminals will allocate two (2) floor runners per gang due to limitations of technology currently. However, in certain terminal with active GPS, RFID and OCR and Next Move capability, there are no clerks at all working with each lifting unit. Most terminals in LA/LB will achieve this status by early 2008.
5. Dockmen/pinmen work against each gang on all vessel quay crane operations.
6. Hatch bosses and lashers are correct as stated.
7. The "driver to take containers off-site" is not a single driver. There are normally 7 / 8 ILWU UTR drivers assigned to work vessel operations in conjunction with each operating vessel gang. There may be more in many instances, depending upon travel distances, and on occasion there may be less. Generally, the actual usage minimum is five (5) with general maximum of twelve (12) in practice.
8. Each Quay gantry crane requires two (2) operators.

iv) Minimum space requirements: Quay Crane can be placed no closer then two bays apart. Forty feet is required between quay crane and any working toploader that is behind it. Obstructions shall not be placed in the immediate active travel area of rail-mounted shore-based cranes or within three feet (3') of moving or traveling parts which would create an area where a person could be pinned, except this shall not apply to crane legs which travel within three feet (3') of the face of the dock, or where less than three feet (3') of clearance between crane legs and gangways exists. When such condition exists, it shall be called to the attention of the workers and they shall use extreme caution whenever they are in these areas. Where employee access to the backreach area of container cranes

Moves per hour	20-35
Backreach (feet)	~50
Outreach (feet)	145 -160
Ships served	16-18 wide Post-Panamax, planning for 21
Cost in Millions (M)	$5-7M (conventional A-frame), $7-11M (modified)
Cycle mode	Single and Double
Development Status	Currently in use

Table 13 Performance Characteristics of Conventional and Modified A-frame Cranes

5 Conclusions and Recommendations

The constraints at port terminals, as well as the legal and corporate inertia strongly suggest any coordinated change in process to accommodate electric cargo conveyor systems at these terminals is not feasible. However, as the containers leave the terminals and enter the community as a large aggregate, local requirements and lack of intermodal capacity imply reasonable but required changes to the container movement process. This report quantifies and documents present terminal load/unload equipment and labor practices and concludes that institutional changes at the terminals is unnecessary in that existing processes with container throughputs of 40 containers/hour are compatible with proposed conveyor-like container movement systems. However, intermodal terminals that collect the containers form the terminals will likely require parallel operation of the multiple cranes and automated container sorting as used in a GRAIL-like system.

6 Implementation

Present near-dock rail processes load train sections on short rail spurs. Each spur has railcars with containers of common destinations beyond the Los Angeles area. These sections are filled over the course of a few days, and are then typically coupled into a train and hauled to railheads outside the Los Angeles basin. There the sections are joined with sections bound for the same destination to from transcontinental trains. Those terminals at the port that do not have near-dock rail or have a limited number of spurs, require the capacity to handle the one million plus containers to be drayed a short distance to Intermodal Container Transfer Facilities (ICTFs) where container trains bound for the inland United States are formed.

A number of conveyor-like technologies for containers have been proposed to mitigate pollution and congestion at the port while maintaining or even increasing throughput by eliminating short haul trucking from terminals to the Alameda Corridor Intermodal Container Transfer Facilities (ICTFs). A low polluting, stationary electrical generating station powering an elevated container conveyor system, will eliminate the pollution and congestion of the one million plus projected drays a year (by 2010).

While the proposed container conveyor approaches have throughput capacities that can handle the anticipated container volume, the loading and off-loading of these systems has yet to be examined in terms of existing terminal procedures. Realities of container terminal labor and logistics may limit the actual throughput capacities of the proposed systems. By nature, a conveyor system will transport a few or even a single container on many dedicated carriages fixed to the guideway. This operation infers continuous flow of carriages mounted on the conveyor. This report has quantifies and documents the conclusion that present terminal equipment and labor practices are compatible with proposed conveyor-like systems

Appendices

Appendix A

Summations of Charts

Tire gantry crane to drayage truck from storage chart 8	
average lift time	1:16
average time between lifts	1:27
containers processed in 8:29 Min	3
Predicted containers per hour	21
Tire gantry crane to drayage truck from storage chart 6	
average lift time	0:43
average time between lifts	2:12
containers processed in 18:14 Min	7
Predicted containers per hour	23
Tire gantry crane to drayage truck from storage chart 4	
average lift time	1:01
average time between lifts	1:35
containers processed in 4:18 min.	2
Predicted containers per hour	27
Tire gantry crane to drayage truck from storage chart 5	
average lift time	0:44
average time between lifts	N/A
containers processed in 2:48 Min.	1
Predicted containers per hour	21
Tire gantry crane to drayage truck from storage chart 5	
average lift time (crane repositions during container travel)	N/A
average time between lifts	3:41
containers processed in 14:45 Min.	5
Predicted containers per hour	20
Averaged Tire gantry crane to drayage truck from storage	
Number of observations	***5***
average lift time	***0:56***
average time between lifts	***2:13***
(containers processed in 48:14 Min.	***18***
Predicted containers per hour	***22***
Toploader loading double stacked train from bombcarts chart 1	
average lift time	1:11
average time between lifts	1:11
containers processed in 31:33 Min	27
Predicted containers per hour	50

Top loader from bomb cart to double stacked train chart 5

Toploader # 1	average lift time	0:30
	average time between lifts	N/A
	containers processed in 30 sec.	1
	Predicted containers per hour	120
Toploader # 2	average lift time	0:29
	average time between lifts	1:02
	containers processed in 2:30 Min.	3
	Predicted containers per hour	72
Toploader # 3	average lift time	0:52
	average time between lifts	1:32
	containers processed in 7:34 Min.	4
	Predicted containers per hour	31

Averaged Toploader loading double stacked train from bombcarts

Number of observations	***4***
average lift time	***0:45***
average time between lifts	***1:15***
containers processed in 42:07 Min.	***35***
Predicted containers per hour	***49***

Truck to double stacked train using rail gantry crane chart 2

Average lift duration	02:03
Average lift to lift time	07:25
Trucks processed in 32:14 min.	5
Predicted containers per hour	9

Truck to double stacked train using rail gantry crane chart 2

Average lift duration	00:31
Average lift to lift time	05:19
Trucks processed in 7:23 min.	2
Predicted containers per hour	16

Averaged Truck to double stacked train using rail gantry crane

Number of observations	***2***
average lift time	***1:17***
average time between lifts	***6:22***
containers processed in 39:37 Min.	***7***
Predicted containers per hour	***10***

Double stacked train loaded using Rail gantry cranes chart 3

average lift time	0:34
average time between lifts	1:28
containers processed in 6:54 min.	5
Predicted containers per hour	43

Double stacked train loaded using Rail gantry cranes chart 3

average lift time	0:36

average time between lifts	1:29
containers processed in 8:55 min.	7
Predicted containers per hour	47

Double stacked train loaded using Rail gantry cranes chart 3

average lift time	0:44
average time between lifts	1:38
containers processed in 8:12 min.	6
Predicted containers per hour	43

Double stacked train loaded using Rail gantry cranes chart 3

average lift time	0:34
average time between lifts	1:22
containers processed in 5:31 min.	5
Predicted containers per hour	54

Double stacked train loaded using Rail gantry cranes chart 3

average lift time	0:58
average time between lifts	1:55
containers processed in 1:55 min.	2
Predicted containers per hour	63

Rail gantry crane to double stacked train chart 7

average lift time	0:44
average time between lifts	1:34
containers processed in 18:54 Min	13
Predicted containers per hour	41

Rail gantry crane to double stacked train

Number of observations	***5***
average lift time	***0:41***
average time between lifts	***1:34***
containers processed in 50:21 Min.	***38***
Predicted containers per hour	***45***

Toploader from storage to bombcart chart 5

Number of observations	***1***
average lift time	***0:39***
average time between lifts	***0:31***
containers processed in 1:50 Min	***2***
Predicted containers per hour	***65***

Toploader from double stacked train to bombcart chart 5

Number of observations	***1***
average lift time	***0:37***
average time between lifts	***1:12***
containers processed in 3:07 Min.	***3***
Predicted containers per hour	***57***

Quay gantry crane to bombcart chart 5

Timing is measured as total time for one cycle

Crane 1	average lift time	N/A
	average time between container load	1:29
	containers processed in 14:03 Min.	11
	Predicted containers per hour	46
Crane 2	average lift time	N/A
	average time between container load	1:25
	containers processed in 12:51 Min.	9
	Predicted containers per hour	56

Quay gantry crane to bombcart

Number of observations	***2***
average time between container load	***1:27***
containers processed in 26:54 Min.	***20***
Predicted containers per hour	***44***

Chart 9

Appendix B

Load Unload charts

toploader loading double stacked train from bombcarts						touch to touch		Estimate containers
	Truck Arrives	Truck Leaves	Container loaded	Repositions				
1	0:30	0:42	1:00					
2	1:16	1:26	1:46	2:06		0:46		
3	2:16	2:26	2:41			1:00		
4	2:58	3:11	3:32	3:49		0:42		
5	3:58	4:10	4:27			1:00		
6	4:41	4:52	5:24	6:15	Dockaloft changes lock	0:43		
7	6:31	6:34	6:55	7:32		1:50		
8	7:48	7:58	8:18	8:56		1:17		
9	8:56	9:24	9:41	9:59	Reset Spreader	1:08		
10	10:13	10:25	10:41	10:54		1:17		
11	11:02	11:15	11:34	11:59		0:49		
12	12:00	12:11	12:27	12:42		0:58		
13	12:52	13:04	13:24		Dockaloft changes lock	0:52		
14	13:43	13:52	14:47	15:19		0:51		
15	15:34	15:42	16:05	17:02		1:51		
16	17:22	17:29	17:46	18:01		1:48		
17	18:11	18:26	18:46			0:49		
18	19:04	19:14	20:04	20:22	Dockaloft changes lock	0:53		
19	20:49	20:59	21:17	21:33		1:45		
20	21:39	21:52	22:19:00	22:57	Dockaloft changes lock	0:50		
21	24:02:00	24:19:00	24:40:00	24:58:00		2:23		
22	25:05:00	25:18:00	25:40:00	26:02:00		1:03		
23	26:08:00	26:21:00	26:41:00	26:58:00		1:03		
24	27:04:00	27:14:00	27:32:00	27:57:00		0:56		
25	28:01:00	28:11:00	28:30:00	30:35:00	Unknown Delay	0:57		
26	30:37:00	30:47:00	31:07:00			2:36		
27	31:22:00	31:33:00				0:45		
							toploader loading double stacked train from bombcarts	
							average lift time	1:11
							average time between lifts	1:11
							containers processed in 31:33 Mi	27
Chart 1							Predicted containers per hour	50

Truck to double stacked train using rail gantry crane					
	Crane #1		Lift time	Time between trucks	
	Lift	Release			
1	01:31	02:51	01:20		
2	07:04	08:40	01:36	05:33	
3	12:41	15:09	02:28	05:37	
4	17:12	20:59	03:47	04:31	
5	31:12	32:14	01:02	14:00	
				Truck to double stacked train using rail gantry crane	
				Average lift duration	02:03
				Average lift to lift time	07:25
				Trucks processed in 32:14 min.	5
				Predicted containers per hour	9
	Crane #2				
	Lift	Release			
6	01:28	01:53	00:25		
7	06:47	07:23	00:36	05:19	
				Truck to double stacked train using rail gantry crane	
				Average lift duration	00:31
				Average lift to lift time	05:19
				Trucks processed in 7:23 min.	2
Chart 2				Predicted containers per hour	16

Double stacked train loaded using Rail gantry cranes								
	Lifts from storage	Drops on train	Train level	Repositions	Lift and drop time	time between lifts		
1				0:18-0:38				
2	1:12	1:48	Bottom 1		0:36			
3	2:19	2:48	Top 2	3:19-3:46	0:29	1:00		
4	4:22	5:07	1		0:45	2:19		
5	5:39	6:06	2	6:33-6:50	0:30	0:59		
6	7:11	7:42	1		0:31	1:36		
					average lift time			0:34
					average time between lifts			1:28
					containerss processed in 6:54 min.			5
					Predicted containerss per hour			43
7	9:13	9:59	2	10:25-10:44	0:46			
8	11:14	11:51	1		0:37	1:52		
9	12:16	13:06	2	13:38-13:57	0:50	1:15		
10	14:28	14:59	1		0:31	1:53		
11	15:37	16:01	2	16:27-16:47	0:24	1:02		
12	17:19	18:00	1		0:41	1:59		
13	18:27	18:54	2	19:20-unknown	0:27	0:54		
					0:36	1:29		
					average lift time			0:36
					average time between lifts			1:29
					containers processed in 8:55 min.			7
					Predicted containerss per hour			47
14	22:17	23:30	1		1:13			
15	23:56	24:30:00	2	24:52-25:28	0:34	1:00		
16	25:27:00	26:13:00	1		0:46	1:43		
17	28:03:00	28:42:00	2	29:06-29:19	0:39	2:29		
18	29:51:00	30:25:00	1		0:34	1:43		
19	31:01:00	31:42:00	2	32:03-unknown	0:41	1:17		
					0:44	1:38		
					average lift time			0:44
					average time between lifts			1:38
					containers processed in 8:12 min.			6
					Predicted containerss per hour			43
20	34:02:00	34:31:00	1		0:29			
21	34:58:00	35:40:00	2	36:03-36:22	0:42	1:09		
22	36:46:00	37:18:00	1		0:32	1:38		
23	37:47:00	38:22:00	2	38:46-39:02	0:35	1:04		
34	39:29:00	40:01:00	1		0:32	1:39		
					0:34	1:22		
					average lift time			0:34
					average time between lifts			1:22
					containers processed in 5:31 min.			5
					Predicted containerss per hour			54
35	41:45:00	42:15:00	1		0:30			
36	42:44:00	44:10:00	2	43:16-43:19	1:26	1:55		
					0:58			
					average lift time			0:58
					average time between lifts			1:55
					containers processed in 1:55 min.			2
Chart 3					Predicted containerss per hour			63

Transtainer from storage to Truck drayage									
Truck Arrives	Container pickup	Location Row and Column		To Row and Column		Container Loaded	Truck leaves	Total time of move	
23:39	23:49	R 2	C 5			25:28:00	25:33:00	1:39	
26:14:00	26:13:00	R 3	C 3			27:16:00	27:27:00	1:03	
	28:10:00	R 3	C 4	R 3	C 3	28:41:00		0:31	
	29:09:00	R 2	C 4	R 1	C 2	30:07:00		0:58	
27:53:00	30:52:00	R 1	C 4			31:49:00	31:52:00	0:57	
						average lift time			1:01
						average time between lifts			1:35
						containers processed in 4:18 min			3
Chart 4						Predicted containers per hour			13

Toploader from bombcart to double stacked train							
			Train level	Touch to touch	Time of lift		
Toploader # 1 1	0:56:00	1:26:00	1		0:30		
						average lift time	0:30
						average time between lifts	N/A
						containers processed in 30 sec.	1
						Predicted containers per hour	120
Toploader # 2 2	2:35:00	3:00:00	2		0:25		
3	3:37:00	4:01:00	1		0:24		
4	4:27:00	5:05:00	2		0:38		
						average lift time	0:29
						average time between lifts	1:02
						containers processed in 2:30 Min	3
						Predicted containers per hour	72
Toploader from double stacked train to bombcart							
5	5:15:00	6:39:00	2		1:24		
6	6:54:00	7:28:00	1		0:34		
7	7:58:00	9:22:00	move from level 2 to 1		1:24		
8	11:27:00	11:57:00	1		0:30		
9	12:19:00	12:49:00	1		0:30		
						average lift time	0:52
						average time between lifts	1:32
						containers processed in 7:34 Min	4
CHART 5 a						Predicted containers per hour	31

Tire gantry crane to drayage truck* (crane repositioning involved)							
Timimg is measured as total time between dispatching one container							
10				15:50:00			
11				18:34:00			
12				25:02:00			
13				27:35:00			
14				30:35:00			
						average lift time	N/A
						average time between lifts	3:41
						containers processed in 14:45 Mi	5
						Predicted containers per hour	20
Toploader from storage to bombcart							
15	31:33:00	32:12:00	2		0:39		
16	32:43:00	33:23:00	1		0:40		
	from ship	to truck			0:39	average lift time	0:39
						average time between lifts	0:31
						containers processed in 1:50 Min	2
						Predicted containers per hour	65
Quay gantry crane to bombcart							
Timimg is measured as total time between two bombcarts							
Crane 1	17			35:55-37:	1:21		
18				39:12-40:	1:19		
19				41:46-43:	1:20		
20				44:23-46:	1:53		
21				47:23-48:	1:52		
22				48:45-49:	1:13		
						average lift time	N/A
						average time between container l	1:29
						containers processed in 14:03 Mi	11
CHART 5 b						Predicted containers per hour	46

Crane 2	23			35:36-37:(	1:28		
24				38:26-39:	1:16		
25				41:07-42:	1:27		
26				43:58-45:	1:17		
27				46:48-48:	1:39		
						average lift time	N/A
						average time between container l	1:25
						containers processed in 12:51 Mi	9
						Predicted containers per hour	56
Toploader from double stacked train to bombcart							
28	50:49:00	51:33:00	1		0:44		
29	52:13:00	52:42:00	2		0:29		
30	53:18:00	53:58:00	1		0:40		
					0:37	average lift time	0:37
						average time between lifts	#####
						containers processed in 3:07 Min	3
						Predicted containers per hour	57
From storage to drayage truck using tire gantry crane							
			Row, Colum, Z	To row, colum, Z			
31	54:41:00	55:25:00	R3 C4 Z2	R2 C6	0:48		
32	55:54:00	56:25:00	R2 C4 Z2	R1 C5	0:31		
33	56:45:00	57:29:00	R1 C4 Z2		0:54		
						average lift time	0:44
						average time between lifts	N/A
						containers processed in 2:48 Min	1
CHART 5 c						Predicted containers per hour	21

Tire gantry from storage to drayage truck						
			Row, colum and Z	To row, colum and Z	Time for lift	
1	43:27:00	43:58:00			0:31	
2	43:58:00	46:05:00			2:07	
3	47:35:00	47:55:00	R 3 C4 Z 2	R 2 C4 Z 2	0:20	
4	49:07:00	49:27:00	R 2 C 6 Z 6		0:20	
5	52:42:00	53:02:00	R 2 C 5 Z 2	R 3 C 4 Z 2	0:20	
6	53:32:00	54:07:00	R 1 C 4 Z 2		0:35	
7	54:50:00	55:40:00	R 2 C 6 Z 2		0:50	
8	58:02:00	58:48:00	R 1 C 5 Z 1		0:46	
9	1:01:33	1:02:12			0:39	
				Tire gantry from storage to drayage truck		
				average lift time		0:43
				average time between lifts		2:12
				containers processed in 18:14 M		7
Chart 6				Predicted containers per hour		23

	Rail gantry crane to double stacked train					
			Train level	Repositions	Lift and drop times	
1	0:26	1:28	Bottom 1		1:02	
2	1:58	2:29	Top 2	2:52	0:31	
				3:07		
3	3:29	4:20	1		0:51	
4	4:45	5:50	2	6:11	0:55	
				6:27		
5	7:18	7:46	1		0:28	
6	8:10	8:51	2	9:13	0:41	
				9:45		
7	10:11	11:10	1		0:59	
8	11:29	12:24	2	12:48	0:55	
				3:12		
9	13:42	14:23	1		0:41	
10	14:48	15:17	2	15:37	0:29	
				15:58		
11	16:27	16:59	1		0:32	
12	17:33	18:34	2	19:00	1:01	
				19:20		
13	19:48	20:22	1		0:34	
				Rail gantry crane to double stacked train		
				average lift time		0:44
				average time between lifts		1:34
				containers processed in 18:54 Min		13
Chart 7				Predicted containers per hour		41

Tire gantry from storage to drayage truck						
			Row, colum and Z	To row, colum and Z	Time for lift	
1	23:19:00	25:58:00			2:39	
2	26:06:00	27:16:00			1:10	
3	28:04:00	28:40:00	R1 C3 Z3	R1 C4 Z3	0:36	
4	29:09:00	30:09:00	R1 C3 Z2	R1 C4 Z1	1:00	
5	30:50:00	31:48:00			0:58	
6					1:16	
					Tire gantry from storage to drayage truck	
					average lift time	1:16
					average time between lifts	1:27
					containers processed in 8:29 Mir	3
Chart 8					Predicted containers per hour	21

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