

## **Appendix F**

### **Selection of Container Ship Terminals and Additional Information Used for Container Ship Cost-Effectiveness Analysis**



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This appendix contains additional information regarding the development of the cost-effectiveness analysis for the container-ship category. The container-ship category was analyzed differently than other categories in that staff reviewed the activities at three terminals considered representative of overall container ship activity. Because of the large number of container ships, it was impractical to base an analysis on the activity of all container ships. This appendix will also provide information that characterizes the three terminals considered in the cost-effectiveness analysis and show how some of the input values used in the cost-effectiveness spreadsheet (See Appendix E) were derived.

Characterization of Three Terminals Considered in Cost-Effectiveness Analysis

As discussed in Chapter V, the basis of the cost-effectiveness analysis for the container-ship category was the analysis of three different terminals at the Port of Los Angeles and Port of Long Beach (POLA/POLB) and associated activity at the Port of Oakland. Based on information provided by shipping companies in response to the ARB Ocean-Going-Vessel Survey and a review of the Marine Exchange information for these ports, three shipping companies were selected, based on various criteria considered for cost effective cold-ironing, including the number of ships making frequent visits (six visits or more), average berthing times, and average number of visits. Table F-1 provides cold-ironing criteria information for these three companies for POLA/POLB.

<b>Table F-1: Cold-Ironing Data for Three Companies</b>			
<b>Company</b>	<b>Number of Ships Making Six or More Visits to POLA/POLB</b>	<b>Average Berthing Time (hrs/visit)</b>	<b>Average Visits to POLA/POLB in 2004</b>
A	37	75	9
B	21	47	9
C	13	67	8

Staff then analyzed the shipping activity at the terminals where ships from Company A, B and C visited. The following tables provide a description of the ship activity at three terminals at POLA/POLB and two terminals at Oakland. The information in the tables represents actual ship activities at these terminals; however, the names of the specific shipping companies and the identities of the terminals have been changed to alleviate any confidentiality issues.

Table F-2 provides information for the ships that visit Terminal 1 at POLA/POLB and Terminal 1 at Oakland, and Table F-3 provides information on the total visits

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made by these ships at the respective terminals. Table F-2 indicates that in 2004, 69 total ships operated by nine different shipping companies visited Terminal 1 at POLA/POLB. The major company, the basis for which the terminal was selected for review, is identified as Company A, and all other shipping companies are identified by number (2, 3 etc.). Of these 69 ships that visited Terminal 1 at POLA/POLB, over half of these ships, or 37 ships, also visited Terminal 1 at Oakland. For POLA/POLB, ships that made at least three visits to these ports represent over 80 percent of the ships, but more than 95 percent of the total ship visits. About 60 percent of these ships also visited Oakland (making between two to eleven visits) and account for nearly all the ship visits to Terminal 1 at Oakland. Similarly, for ships that made at least six visits to POLA/POLB, these ships represent nearly 55 percent of the ships that visited the terminal and over 75 percent of the total ship visits. About 50 percent of these ships also visited Oakland and account for 75 percent of the ship visits to Terminal 1 at Oakland. Note that Terminal 1 at Oakland also received visits from 15 bulk ships. These ships did pick up containers at Oakland (storing the containers above deck), but because these ships are somewhat different than a container ship (which store containers both above and below deck), were not included in subsequent analysis of the terminal.

<b>Table F-2: Ship Activity at Terminal 1</b>						
<b>Company</b>	<b>POLA/POLB</b>			<b>Oakland</b>		
	<b>Total Ships</b>	<b>Ships with 3+ Visits</b>	<b>Ships with 6+ Visits</b>	<b>Total Ships</b>	<b>Ships with 3+ Visits*</b>	<b>Ships with 6+ Visits*</b>
A	33	27	17	19	19	15
2	3	3	2	3	3	2
3	12	10	3	0	0	0
4	11	8	8	6	4	4
5	3	3	1	2	3	1
6	1	1	1	1	1	1
7	3	3	3	3	3	3
8	1	0	0	2	0	0
9	2	2	2	0	2	2
Total Container Ships	69	57	37	37	35	28
Non-Container Ships	NA	NA	NA	15	NA	NA
Total Ships	69	57	37	52	35	28

\* Number of ships includes ships that made three or six or more visits to POLA/POLB and made one or more visit to Oakland

<b>Table F-3: Visits by Ships at Terminal 1</b>						
	<b>POLA/POLB</b>			<b>Oakland</b>		
	<b>Total Ships</b>	<b>Ships with 3+ Visits</b>	<b>Ships with 6+ Visits</b>	<b>Total Ships</b>	<b>Ships with 3+ Visits*</b>	<b>Ships with 6+ Visits*</b>
Total Ship Visits	425	410	325	219	217	180*

\* Total visits for Oakland based upon ships that made either 3 or 6 or more visits to POLA/POLB and all subsequent visits by these ships to Oakland

Tables F-4 and F-5 provides similar information for Terminal 2 at POLA/POLB and Terminal 2 at Oakland. At Terminal 2 of POLA/POLB, 37 ships operated by three companies visited in 2004. Again, the major company is identified as Company B and all other ship companies are identified by number. As shown in Table F-5, based on total ship visits, Terminal 2 at POLA/POLB had about 50 percent of the activity of Terminal 1 and almost half the number of ships that made three visits or six visits as compared to Terminal 1. Of the 37 container ships that visited Terminal 2 at POLA/POLB, 27 ships also visited Terminal 2 at Oakland. For POLA/POLB, ships that made at least three visits to these ports represent nearly 85 percent of the ships, but more than 95 percent of the total ship visits. About 90 percent of these ships also visited Oakland (making between one to thirteen visits) and account for over 95 percent of the ship visits to Terminal 2 at Oakland—a much higher percentage than Terminal 1. Similarly, for ships that made at least six visits to POLA/POLB, these ships represent 60 percent of the ships that visited the terminal and 85 percent of the total ship visits. About 66 percent of these ships also visited Oakland and account for nearly 90 percent of the ship visits to Terminal 2 at Oakland.

Furthermore, there were 15 additional container ships that visited Terminal 2 at Oakland. Most of these ships also visited the POLA/POLB, but at a different terminal. Since staff was reviewing the impacts of cold-ironing ships that visited both Terminal 2 at POLA/POLB and Terminal 2 at Oakland, staff excluded these ships from the cost-effectiveness analysis for this terminal. (If we assume that all container-ship terminals would add cold-ironing infrastructure, then staff could have included these additional ships in the analysis. The inclusion of these additional ships would have improved the cost effectiveness of cold-ironing Terminal 2 at Oakland. Cost effectiveness improves with more ships using the same terminal—more ships to share the overall cost for cold-ironing.)

<b>Table F-4: Ship Activity at Terminal 2</b>						
	<b>POLA/POLB</b>			<b>Oakland</b>		
<b>Company</b>	<b>Total Ships</b>	<b>Ships with 3+ Visits</b>	<b>Ships with 6+ Visits</b>	<b>Total Ships</b>	<b>Ships with 3+ Visits*</b>	<b>Ships with 6+ Visits*</b>
A	31	25	17	26	23	17
2	5	5	5	0	0	0
3	1	1	1	1	1	1
Total Container Ships	37	31	23	27	24	18
Non-Container Ships	6	NA	NA	NA	NA	NA
Container Ships From Other Companies That Went To Different Terminal in POLA/POLB	NA	NA	NA	15**	10**	7**
Total Ships	37					

\* Number of ships includes ships that made three or six or more visits to POLA/POLB and made one or more visit to Oakland

\*\*These ships were excluded from analysis

<b>Table F-5: Visits by Ships at Terminal 2</b>						
	<b>POLA/POLB</b>			<b>Oakland</b>		
	<b>Total Ships</b>	<b>Ships with 3+ Visits</b>	<b>Ships with 6+ Visits</b>	<b>Total Ships</b>	<b>Ships with 3+ Visits*</b>	<b>Ships with 6+ Visits*</b>
Total Ship Visits	238	232	203	131**	127**	115**

\* Total visits for Oakland based upon ships that made either 3 or 6 or more visits to POLA/POLB and all subsequent visits by these ships to Oakland

\*\*Excludes container ships visiting other terminals at POLA/POLB. These ships account for 63 visits (three plus visits) and 56 visits (six plus visits).

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Finally, Tables F-6 and F-7 provides information for Terminal 3 at POLA/POLB. The major shipping company is identified as Company C in Table F-6. Terminal 3 at POLA/POLB had about the same ship visits as Terminal 2, but of the 75 container ships that visited Terminal 3, only 50 percent of these ships visited POLA/POLB three or more times and less than 20 percent of these ships visited POLA/POLB six or more times. Visits made by these two groups represent about 80 and 40 percent of the total visits to Terminal 3, respectively.

Finally, Terminal 3 also had two non-container ships visit. These ships were excluded from subsequent analysis. In addition, the tables show that a small number of ships that visited Terminal 3 at POLA/POLB also visited Oakland—only nine ships out of 75 total ships visiting Terminal 3 also visit Oakland. In addition, the total visits from these ships only account for 32 visits. Because of the low percentage of ships visiting Oakland from Terminal 3, for this report, no further analysis was done for ships visiting Oakland.

<b>Table F-6: Ship Activity at Terminal 3</b>				
	<b>POLA/POLB</b>			<b>Oakland</b>
<b>Company</b>	<b>All Ships</b>	<b>Ships with 3+ Visits</b>	<b>Ships with 6+ Visits</b>	<b>Total Ships**</b>
A	26	20	12	1
2	7	2	0	7
3	17	2	0	1
4	1	0	0	0
5	23	16	1	0
6	1	0	0	
Total Container Ships	75	40	13	9
Non-Container Ships	2*	0	0	0
Total Ships	77	40	13	9

\* These ships were excluded from analysis

\*\* Because nearly all ships that visited Terminal 3 at POLA/POLB did not visit Oakland, no further analysis was done for Oakland

<b>Table F-7: Visits by Ships at Terminal 3</b>				
	<b>POLA/POLB</b>			<b>Oakland</b>
	<b>All Ships</b>	<b>Ships with 3+ Visits</b>	<b>Ships with 6+ Visits</b>	<b>All Ships</b>
Total Ship Visits	249*	200	99	32

\*Excludes visits from non-container ships

Average Auxiliary Engine Size

Emissions from a ship are proportional to its size. Larger ships will have higher power demands, and to meet this demand, the auxiliary engines will need to be larger. Based upon the response to the ARB Ocean-Going-Vessel Survey, ARB staff received information on the capacity of auxiliary engine power, in kW, on various ships. However, for the majority of ships, staff had to estimate this capacity based upon twenty-foot equivalent units (TEU). (Dead weight tons were used for other ship categories). For container ships, the results of the survey data indicated that the total kW for the auxiliary engines correlated well with the TEU capacity of containerships—the total power for the ship’s auxiliary engines, in kW, is about 1.7 times the TEU capacity of the ship. For example, a container ship with a TEU carrying capacity of 2,000 TEU will have auxiliary engines that can provide up to 3,400 kW of power.

For Terminal 1 at POLA/POLB, Table F-8 provides information for the range in size of ships that visited this port for ships that made six or more visits. The average size ship that visited Terminal 1 at POLA/POLB, based on TEU capacity, was about 3,350 TEU. Based on the power/TEU ratio given above, the average power requirement of the auxiliary engines is about 5,700 kW for the ships that visited Terminal 1 at POLA/POLB.

<b>TEU Capacity</b>	<b>Number of Ships</b>
5000+	11
4000-4999	6
3000-3999	2
2000-2999	6
1000-1999	10
<1000	2
Average	3,348 TEU

Information on the TEU capacity of ships is generally available on the Internet. (See Chapter XV, References.)

Berthing Times

In general, the berthing times used for the container-ship analyses were provided by shipping companies in response to the ARB Ocean-Going-Vessel Survey. The survey requested that berthing times be provided for each ship that made at least five visits to the same California port. In general, survey results were used

if available. In the case where survey results are not available, staff used an average berthing time that is specific to the size of the ship, in TEU capacity. This average berthing time is based upon the responses to the Survey.

Table F-9 provides an example of how the berthing time was determined for ships making six or more visits to Terminal 1 at POLA/POLB. As shown in the table, Survey results were available for 26 ships. Averages, based upon Survey responses, were used for 11 ships. The average berthing time for these 37 ships is 75 hours per visit.

<b>TEU Capacity</b>	<b>Company</b>	<b>Number of Ships</b>	<b>Berthing Times (Hr/Visit)</b>
5000+	A	11	102
4000-4999	A	2	52
4000-4999	4	4	41
3000-3999	A	2	82
2000-2999	7	3	69
2000-2999	6	1	74
2000-2999	Survey Average	2	70
1000-1999	4	3	74
1000-1999	Survey Average	7	70
<1000	Survey Average	2	40
Average			75

### Ship Visits

Ship visits are based upon actual visits by each ship to the applicable terminal, as indicated in the Marine Exchange Data for POLA/POLB. As an example of how the average ship visits were determined, Table F-10 provides the number of visits made by the container ships that visited Terminal 1 in POLA/POLB six or more times. As shown in Table F-11, in 2004, these frequent flyers made 325 total visits, or about nine visits per ship.

<b>Table F-10: Number of Visits for Ships That Made Six or More Visits to Terminal 1 at POLA/POLB</b>			
<b>Name of Ship</b>	<b>Number of Visits</b>	<b>Name of Ship</b>	<b>Number of Visits</b>
A1	7	A10	9
A2	9	A11	10
A3	9	A12	8
A4	8	A13	11
A5	25	A14	6
A6	7	A15	10
A7	10	A16	6
A8	10	A17	10
A9	24		
2a	6	2b	7
3a	6	3b	7
4a	7	4e	6
4b	8	4f	7
4c	8	4g	6
4d	8	4h	6
5a	7		
6a	7		
7a	10	7c	10
7b	9		
8a	NA		
9a	7	9b	8
10a	6		

<b>Table F-11: Averages for Terminal 1 at POLA/POLB</b>	
Total visits 2004	325
Average visits for 2004	8.8