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Port of San Diego: Cold Ironing Study May 2007

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PREFACE AND ACKNOWLEDGEMENTS

Preface

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ACRONYMS

APCD	Air Pollution Control District
AQMD	Air Quality Management District
CAA	Clean Air Act
CARB	California Air Resources Board
CO	Carbon Monoxide
EPA	United States Environmental Protection Agency
ERC	Emissions Reduction Credit
HRA	Health Risk Assessment
IC	Internal Combustion
MDO	Marine Diesel Oil
MGO	Marine Gasoline Oil
MERC	Mobile Source Emission Reduction Credits
MSD	Medium Speed Diesel
MW	Megawatts
NMHC	Non-Methane Hydrocarbon
NO_X	Oxides Of Nitrogen
ODC	Ozone Depleting Compound
OGV	Ocean Going Vessels
PERP	Portable Equipment Registration Program
PM_{10}	Particulate Matter 10 Microns Or Less
$PM_{2.5}$	Particulate Matter 2.5 Microns Or Less
POSD	Port of San Diego
RO	Residual Oil
ROC	Reactive Organic Compound
ROG	Reactive Organic Gases
SDAPCD	San Diego County Air Pollution Control District
SDG&E	San Diego Gas and Electric
SIP	State Implementation Plan
SO_X	Oxides Of Sulfur
TACs	Toxic Air Contaminants
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Cold Ironing is the process of powering an ocean going vessel or other craft with shore based electrical power in lieu of the vessel using its on board auxiliary engine generator sets when the vessel is at the dock. The period of time when the vessel is at the dock is referred to as "hotelling". Cold Ironing (also called "Shore Power") has been used by the US military for over 50 years and has recently been applied in Juneau, Alaska and the Port of Seattle for cruise ships. Other California ports are currently planning or implementing shore power for cargo vessels. This study is designed to provide information related to the potential for cold ironing in the Port of San Diego (POSD) at the Cruise Ship Pier B Terminal as well as the Dole Reefer Vessels at the 10th Avenue Marine Terminal. This study includes data collected on the vessel visits, air pollutant emission calculations, a Net Present Value (NPV) Cost Effectiveness Analysis, and a discussion of the requirements for either Emission Reduction Credits (ERC's) or Mobile Emission Reduction Credits (MERC's)

The POSD has 21 Cruise ships visiting the port from eight cruise lines with a total number of 235 visits scheduled for 2007. The ships come into port in the morning and depart in the late afternoon or early evening. The total quantity of NOx emissions estimated for 2007, for all of the cruise ship visits while hotelled at Pier B, is approximately 245 tons. Several of the ships currently visiting have the capability to accept shore power. If Pier B were currently configured with shore power and these ships utilized the shore power, NOx emissions could be reduced by approximately 18%. If all of the cruise ships were shore powered, emission reductions of 80% could be achieved with the assumption that connection time upon arrival and departure is one hour or about 20% of the hotelling time. (Since not all Cruise ships have the power connections on the same side of the ship, Pier B would need to be equipped with capability on both the North and South sides of the pier.)

The Dole RMS company has three vessels which routinely visit the POSD's 10th Avenue Marine Terminal. Each Dole vessel is on a three week schedule: loading in South America and Central America before arriving and unloading in POSD. Therefore, the port receives one of these ships every three weeks in rotation. Each visit is approximately 62 hours in length. The total NOx emissions estimated for 2007, for all 52 visits, is 127 tons. If all three ships were shore powered capable, emission reductions of 97% could be achieved.

Cold Ironing cost effectiveness is an analysis of the relationship between the costs to implement cold ironing and the NO_X emissions reduced by using the shore power. Typically, the cost effectiveness is expressed in terms of the cost (in dollars) of reducing one ton of NO_X over a ten year period. To prepare this Cost Effectiveness Net Present Value (NPV) analysis, several assumptions are required which can greatly affect the calculated values. Every effort has been made to make these assumptions transparent so that, as additional information becomes available, the impacts can be clearly understood and analyzed. Furthermore, this analysis is intended only to provide a rough estimate with the best information available now and is not a detailed study of this issue. The cost effectiveness for the cruise ships is approximately $23,500/ton of NOx reduced and for the Dole Vessels approximately $13,700/ton of NOx reduced. The largest contributor to the cost is the SDG&E infrastructure to bring power to the terminals followed by electrical infrastructure at the terminals, ship electrical modifications, and net vessel operator energy costs. The Dole vessels at the 10th Avenue Terminal are estimated to be more cost effective when compared to the Cruise Ships at Pier B.

ERC's or MERC's applications could be prepared under Rule 26 or Rule 27 of the San Diego Air Pollution Control District Rules and Regulations. Since the ERC's and MERC's can have significant value, the applicant must demonstrate that the emission reductions are Real, Surplus, Quantifiable, Enforceable, and Permanent in order to obtain the air credits. Once the ERC's or MERC's are granted by the SDAPCD, they would have value to large power generators or large projects generating more than 50 tons of NOx per year. Assessing the value of the ERC's or MERC's can be uncertain due to the limited market and limited availability of these credits. This study uses values of $75,000 per ton based on information from the district and an environmental credit brokerage firm. Pending regulations can also reduce the value of the credits since generally the reductions must be "surplus" to any established or proposed requirements. Because the cruise ship visits do not currently have a predetermined, long term schedule and the because of the uncertainty of the pending shore power regulation for "infrequent visitors", we recommended that the cruise ship ERC or MERC applications be delayed until a definitive regulatory framework is specified. For the Dole vessels, based upon the currently proposed shore power regulation, it appears that temporary credits that would expire in 2015 may be generated, if the shore powering can be implemented in a timely fashion.

1.0 PORT OF SAN DIEGO COLD IRONING STUDY INTRODUCTION

The "hotelling" operations at the Cruise Ship Terminal (Pier B) and 10th Avenue Marine Terminal by the Dole RMS represent a significant portion of the air emissions from shipping activity in the Port of San Diego (POSD). As part of their environmental program, the POSD is interested in understanding the ship emissions while hotelling in order to investigate the potential of cold ironing (also known as "shore powering") to reduce those emissions. The purpose of this study is to gather and analyze the data associated with the berthing operations and resulting emissions to better define the potential for emissions reductions and the opportunity to create Emission Reduction Credits (ERCs) or Mobile Source Emission Reduction Credits (MERCs).

Currently, when a cruise ship visits the POSD, the cruise ship continues to run its diesel-electric engine to generate electrical power as needed for the ship. This pier side power generation is referred to as "hotelling." Similarly, when the refrigerated cargo vessels (also called "reefers") operated by Dole (to transport tropical fruit) arrive at dock. They generate power by operating the ship's auxiliary engines until their load is transferred to shore. This power is needed to provide both electricity for the ship operations as well as refrigeration for the cargo until it is offloaded. The electrical power demand from the cruise ships and reefers during these operations is significant.

Sections 2 and 3 of this report summarize the background information required to understand the scope of the Cruise and Dole Ships operations, including:

- POSD visit schedules;
- Operational schedules while in port;
- Specific vessel auxiliary/diesel-electric engine and fuel data;
- Power demand cycles; and
- Emissions generated.

Sections 4 and 5 of this study continue the development of a cold ironing study, looking at the potential cost effectiveness of cold ironing and criteria for ERC/MERC applications. A Net Present Value (NPV) Financial Analysis of the basic elements of cold ironing, including the cost of shore side infrastructure, the cost of ship modifications, increased net cost of power to the ship operator, and the value of ERC/MERCs is performed for a 10-year operating period with a discount rate of 5%.

This study has been prepared based upon the published methodologies and data provided by the United States Environmental Protection Agency (EPA), the California Air Resources Board (CARB) and other port studies to ensure accuracy and consistency. (Where data was available from the EPA, CARB, and/or private studies, the data from the agencies was typically preferred.)

2.0 CRUISE SHIP DATA

2.1 Cruise Ship Visit Schedules

Currently scheduled for 2007, there will be eight (8) cruise lines visiting the POSD with twenty-one different ships. Each of the vessels dock at either the north or south side of Pier B, unless there are more than two vessels visiting the POSD at one time. Occasionally there are three ships visiting the POSD resulting in the use of the adjacent Broadway Pier. The cruise lines have seasons where the ships will be in a certain region so the distribution of visits is not necessarily even throughout the year. Some of the ships currently visiting the port have installed the necessary ship side electrical infrastructure to accept shore power and are noted with an asterisk in the table below.

A summary of the 2007 scheduled visits is shown in Table 2-1 below. A detailed schedule of visit dates is included in Appendix A.

Table 2-1: 2007 Schedule Visits for Port of San Diego

Vessels Name	Cruise Line	2007 Scheduled Visits	Cold Ironing Capable
Monarch of The Seas	Royal Caribbean	51	
Elation	Carnival	48	
Oosterdam*	Holland America	29	Yes
Carnival Spirit	Carnival	24	
Ryndam	Holland America	17	
Zaandam	Holland America	15	
Dawn Princess*	Princess	14	Yes
Mercury	Celebrity	11	
Summit	Celebrity	5	
Serenade of The Seas	Royal Caribbean	3	
GTS Infinity	Celebrity	4	
Volendam	Holland America	3	
Crystal Symphony	Crystal	2	
Radiance of The Seas	Royal Caribbean	2	
Silver Shadow	Silver	1	
Rhapsody of The Seas	Royal Caribbean	1	
Diamond Princess*	Princess	1	Yes
Sun Princess*	Princess	1	Yes
Amsterdam	Holland America	1	
Norwegian Sun	Norwegian Cruise Line	1	
Zuiderdam	Holland America	1	

* Ships capable of shore power

As Table 2-1 demonstrates, eight ships account for 209 of 235 visits or 89% of the visits to the POSD. The four ships previously equipped with cold ironing capability represent 45 visits or 19% of the planned 2007 visits. Two of the top eight, the Dawn Princess and the Oosterdam, have been equipped to accept shore power. Six additional ships of the top eight would need to be configured to accept shore power in order for 89% of the visits to be shore power capable.

2.2 Cruise Ship Duration and Docking Information

The cruise ships usually dock at either the north or south side of Pier B. Typically, the ships arrive in the morning and depart in the late afternoon or early evening. To connect to shore

power upon arrival, the ship operators will require some time to transition the ship from ship power to shore power. Likewise, upon departure, the operator will need time to transition from shore power back to ship power. For this study, one hour is the assumed time required to transition to or from shore power (*Ref. 12*). Thus, if a cruise ship is at dock for 10 hours, the available time for shore power is assumed to be eight (8) hours. Table 2-2 shows the 2007 average berthing time for the cruise ships and the time available for shore power.

Table 2-2: 2007 Average Berthing Time

Ship	2007 Scheduled Visits	Total Average Berthing Time (hrs)	Time Available for Shore Power (hrs)
Monarch of The Seas	51	9.25	7.25
Elation	48	10	8
Oosterdam*	29	11	9
Carnival Spirit	24	11.5	9.5
Ryndam	17	10.5	8.5
Zaandam	15	10.5	8.5
Dawn Princess*	14	11	9
Mercury	11	8	6
Summit	5	10	8
Serenade of The Seas	3	13.5	11.5
GTS Infinity	4	10	8
Volendam	3	10.5	8.5
Crystal Symphony	2	3	1
Radiance of The Seas	2	10.5	8.5
Silver Shadow	1	11	9
Rhapsody of The Seas	1	10	8
Diamond Princess*	1	11.5	9.5
Sun Princess*	1	11.5	9.5
Amsterdam	1	10.5	8.5
Norwegian Sun	1	10	8
Zuiderdam	1	10	8
Totals	235		
Average		10.2	8.2

* Vessels equipped with shore power capability as of December 2006
Red Text – Estimated Data

2.3 Cruise Ship Engine Information

The cruise ships use multiple engines for efficiency and redundancy. Cruise ships typically use a diesel- electric engine configuration where the engines generate electrical power which is then used to drive the ship's propulsion systems and provide auxiliary power (*Ref. 12*). The engine information below is divided into two categories: 1) Ships currently configured to accept shore power (i.e., "shore power capable"), and 2) ships not currently equipped to accept shore power (i.e., "not shore power capable").

2.3.1 Auxiliary Engine Data – Shore Power Capable Ships

For the ships currently equipped with shore power capability, this study collected actual data from the ship operators in preparation for any MERC or ERC activity. For the actual emission calculations in this report this engine data was not used. The methodology outlined in section 2.3.2 was used.

Table 2-3: Auxiliary Engine Data

Vessel	Engine Make	Model	Number	Speed (rpm)	Fuel	Maximum Power Rating (bhp)
Dawn Princess	Wartsila	ZA40S 16 V	4	514	ISO DMA	15,449
Diamond Princess	Wartsila	W46C-9L	2	514	ISO DMA	12,673
	Wartsila	W46C-8L	2	514	ISO DMA	11,265
	General Electric	LM2500	1	3600*	ISO DMA	33,256
Sun Princess	Wartsila	ZA40S 16 V	4	514	ISO DMA	15,449
Oosterdam	TBD	TBD	TBD	TBD	TBD	TBD

*Gas Turbine Engine
TBD – To be determined, used engine Data from Reference 12

2.3.2 Auxiliary Engine Data - Ships Not Currently Shore Power Capable

For the remaining vessels, not equipped for shore power, engine data is derived from the January 2006 EPA document, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", that outlines the methodology for mid-tier port emission inventories by ship type (*Ref. 12*). This approach, although not specific to each ship, gives an average emission estimate.

Using this methodology, the multiple auxiliary engines on each ship are assumed to be meeting the new CARB Fuel Rule 17CCR sec. 93118. This rule requires the use of marine gas oil (MGO) or marine diesel oil (MDO), with 0.5% sulfur as of January 1, 2007, within 24 miles of the California coast for auxiliary engines or diesel-electric engines. All engines are assumed to be medium speed category 3 engines fueled by MGO with a 0.5% sulfur content. The auxiliary engines are assumed to have a total average maximum electrical generation capacity of 11,000 kW and a duty cycle of 0.64 per EPA's emission methodology (*Ref. 12*).

2.4 Cruise Ship Power Demands

Cruise ships generate significant electrical power loads while docked. Table 2-4 shows the average electrical power loads expected for the cruise ships visiting the POSD. The average load is calculated from EPA methodologies for a mid-tier inventory (*Ref. 12*). A mid-tier inventory is often used when there are a large number of ships. For individual ships specific duty cycles should be used. Load estimate adjustments were made to account for smaller cruise ships based on the passenger counts. Cruise ships with passenger count between 250 and 750 are considered 25% of the average load and for cruise ships with passengers between 750 and 1250 are considered 50% of the average load. The total power usage in kW-hrs is also provided to give relative total power consumption between the various vessels. The total shore power per visit is calculated by multiplied the average load by the time available for shore power. The vessel passenger counts were provided by POSD datebase.

Table 2-4: Cruise Ship Power Demands

Vessel	2007 Scheduled Visits	Total Average Berthing Time (hrs)	Time available for Shore Power (hrs)	Average Load (kW)	Total Shore Power/ Visit (kW-Hr)	Vessel Passengers
Monarch of The Seas	51	9.25	7.25	7,040	51,040	2,774
Elation	48	10	8	7,040	56,320	2,200
Oosterdam*	29	11	9	7,040	63,360	1,848
Carnival Spirit	24	11.5	9.5	7,040	66,880	2,300
Ryndam	17	10.5	8.5	7,040	59,840	
Zaandam	15	10.5	8.5	7,040	59,840	1,440
Dawn Princess*	14	11	9	7,040	63,360	1,950
Mercury	11	8	6	7,040	42,240	1,870
Summit	5	10	8	7,040	56,320	
Serenade of The Seas	3	13.5	11.5	7,040	80,960	2,501
GTS Infinity	4	10	8	7,040	56,320	
Volendam	3	10.5	8.5	7,040	59,840	1,440
Crystal Symphony	2	3	1	3,520	3,520	940
Radiance of The Seas	2	10.5	8.5	7,040	59,840	1,950
Silver Shadow	1	11	9	1,760	15,840	382
Rhapsody of The Seas	1	10	8	7,040	56,320	
Diamond Princess*	1	11.5	9.5	7,040	66,880	2,670
Sun Princess*	1	11.5	9.5	7,040	66,880	1,950
Amsterdam	1	10.5	8.5	7,040	59,840	1,380
Norwegian Sun	1	10	8	3,520	28,160	1,200
Zuiderdam	1	10	8	7,040	56,320	
Total	**192**					
Average		**10.2**	**8.2**	**6,453**	**53,806**	

2.5 Cruise Ship Emissions

Cruise ships typically use diesel-electric engine configurations where the engines are used to run generator sets. The electrical energy from the generator sets in turn is used to drive the propulsion system and support the ships electrical needs. According to the EPA's methodology, the current practice to calculate emissions from oceangoing vessels (OGVs) is to use energy-

based emission factors together with activity profiles for each vessel (*Ref. 12*). The emissions for the OGVs can be determined by the equation below:

$$\text{Emissions (g)} = \text{Maximum Power (kW)} \times \text{Load Factor} \times \text{Activity (h)} \times \text{Emission Factor (g/kWh)}$$

EPA's emission factors are based on fuel type. Historically almost all of these ships have used residual oil (RO) for their engine-generator sets. However, since this study will be looking at the emission reductions from a 2007 baseline (i.e., potential "surplus emissions"), MGO is used for calculating the emissions. MGO or MDO with 0.5% sulfur content is required by CARB as of January 1st, 2007 for auxiliary engine use or diesel-electric use inside of 24 nautical miles of the coast (*Ref. 8*).

2.5.1 Cruise Ship Emission Factors

The emission factors used in this report are located in the EPA document "Current Methodologies and Best Practices in Preparing Port Emission Inventories" January 2006 (*Ref. 12*). The most current set of auxiliary engine emission factors comes from the "Port of Los Angeles 2001 Air Emissions Inventory" (*Ref. 10*). According to EPA's data collection, most cruise ships have medium speed diesel engines. Medium diesel engines are classified as four stoke engines with engine speeds between 130 to 1400 revolutions per minute. Auxiliary engine emission factors are given in Table 2-5. Please note: MGO from Table 2-5 meets the minimum CARB fuel requirements for 2007.

Table 2-5: Table from EPA 2-10 Auxiliary Engine, Medium Speed with Different Fuels

Engine	Fuel	NO_X (g/kW-h)	CO (g/kW-h)	HC (g/kW-h)	PM_{10} (g/kW-h)	$PM_{2.5}$ (g/kW-h)	SO_2 (g/kW-h)
MSD	RO	14.7	1.1	0.40	1.14	1.10	11.1
MSD	MDO	13.90	1.10	0.40	0.75	0.28	6.16
MSD	MGO	13.90	1.10	0.40	0.42	0.23	2.05

MSD = Medium Speed Diesel
RO = 2.7% sulfur content
MDO = 1.5% sulfur content
MGO = 0.5% sulfur content

2.5.2 Emission Calculations

To calculate emission reductions due to cold ironing, the emissions associated with available shore power time is calculated. The emission factors from Section 2.5.1 are multiplied by the time available for shore power Table 2-2, and total shore power per visit in Table 2-3. Table 2-6 below shows the annual hotelling emission reduction potential, including all of the scheduled visits for 2007.

Table 2-6: Annual Hotelling Emission Reduction Potential for Cruise Ships-MGO

Vessel	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Monarch of The Seas	39.85	3.15	1.15	1.20	0.66	5.88
Elation	41.38	3.27	1.19	1.25	0.68	6.10
Oosterdam*	28.13	2.23	0.81	0.85	0.47	4.15
Carnival Spirit	24.57	1.94	0.71	0.74	0.41	3.62
Ryndam	7.79	0.62	0.22	0.24	0.13	1.15
Zaandam	13.74	1.09	0.40	0.42	0.23	2.03
Dawn Princess*	13.58	1.07	0.39	0.41	0.22	2.00
Mercury	7.11	0.56	0.20	0.21	0.12	1.05
Summit	4.31	0.34	0.12	0.13	0.07	0.64
Serenade of The Seas	3.72	0.29	0.11	0.11	0.06	0.55
GTS Infinity	3.45	0.27	0.10	0.10	0.06	0.51
Volendam	2.75	0.22	0.08	0.08	0.05	0.41
Crystal Symphony	0.11	0.01	0.00	0.00	0.00	0.02
Radiance of The Seas	1.83	0.14	0.05	0.06	0.03	0.27
Silver Shadow	0.24	0.02	0.01	0.01	0.00	0.04
Rhapsody of The Seas	0.86	0.07	0.02	0.03	0.01	0.13
Diamond Princess*	1.02	0.08	0.03	0.03	0.02	0.15
Sun Princess*	1.02	0.08	0.03	0.03	0.02	0.15
Amsterdam	0.92	0.07	0.03	0.03	0.02	0.14
Norwegian Sun	0.43	0.03	0.01	0.01	0.01	0.06
Zuiderdam	0.22	0.02	0.01	0.01	0.00	0.03
Total	**197.03**	**15.59**	**5.67**	**5.95**	**3.26**	**29.06**

Emissions in tons per year (tpy).

Table 2-7: Summary of Emissions from All Cruise Ships

	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Totals Air Emissions	245.21	19.40	7.06	7.41	4.06	36.16
Total Emissions Available for Shore Power (minus hookup time)	197.03	15.59	5.67	5.95	3.26	29.06
% Emissions Reduction Potential	**80.4%**	**80.4%**	**80.4%**	**80.4%**	**80.4%**	**80.4%**

Table 2-8: Summary of Emissions from Cruise Ships Currently Shore Power Capable

	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Totals Air Emissions	53.45	4.23	1.54	1.62	0.88	7.88
Total Emissions Available for Shore Power (minus hookup time)	43.75	3.46	1.26	1.32	0.72	6.45
% Emissions Reduction Potential	**81.9%**	**81.9%**	**81.9%**	**81.9%**	**81.9%**	**81.9%**
% Reduction of Total for Shore Power Ships	**17.8%**	**17.8%**	**17.8%**	**17.8%**	**17.8%**	**17.8%**

3.0 PIER 10 - DOLE REEFER DATA

The 10th Avenue Pier located in the Port of San Diego is where Dole berths its ships which are bringing in agricultural products (bananas, pineapples, mangos, etc.) packed in refrigerated cargo containers ("reefers") from Central and South America. The cargo containers require electrical power for the refrigeration which is provided by the vessel while in transit and upon arrival. After the refrigerated containers are unloaded, power is provided by 512 power poles (installed in 2003) in an adjacent facility. Unlike the cruise ships which berth for only part of a day, the Dole vessels stay at port for an average of approximately 62 hours. The ship berthing and unloading operations also require a unique duty cycle on the auxiliary engines producing a declining electrical power demand due to the unloading operations.

3.1 Dole Vessel Visit Schedule Summary and Berthing Time

Table 3-1 outlines the actual average berthing times from the Marine Exchange Database (Appendix E). Since each ship is of the same configuration, the times expected are quite close. Variations between these sister vessels are not expected to be significant as the typical operations are consistent. In addition, the containers are fully cooled during transport, and temperatures at the dock do not generally vary greatly throughout the year. Based upon the data shown below, a 62.4 hour average visit duration is assumed to quantify the emissions per visit and annual total.

Table 3-1: Dole Vessel Berthing Data

Vessel Name	Vessel ID	Vessel Owner	2006 Average Berthing Time per Visit (hrs)	Berthing Time Available for Shore Power (hrs)
Dole Costa Rica		Tropical Shipping Italiana	60:52	58:52
Dole Honduras		Tropical Shipping Italiana	59:46	57:46
Dole Ecuador	8513479	Tropical Shipping Italiana	65:47	63:47

3.2 Dole Vessel Engine Information

Dole is expecting to continue to run the three sister ships to the Port of San Diego: the "Costa Rica", the "Honduras", and the "Ecuador." Each of these ships is equipped with the same set of six (6) auxiliary engines listed in the table below. The engine data below was provided by Dole in response to Yorke Engineering's survey.

Table 3-2: Dole Vessel Engine Specifications

Manufacturer	Model	Year Built	Power Rating (kW)	Revolutions/Minute
Bergen	KRG9	1988	1,360	720
Bergen	KRG9	1988	1,360	720
Bergen	KRG8	1988	1,200	720
Bergen	KRG8	1988	1,200	720
Bergen	KRG8	1988	1,200	720
Bergen	KRG6	1988	900	720

3.3 Dole Vessel Power Duty Cycle

The Dole vessel auxiliary engines are used primarily for refrigeration of the fruit cargo. The cargo is contained in refrigerated containers with power supplied by the ship's auxiliary engines.

As the containers are removed from the vessel, the refrigeration power demand goes down creating a declining power demand duty cycle. The Ecuador's chief engineer and captain provided the data estimates shown in Figure 3-1 which are used as the power cycle for the reefer emission calculations.

The Dole vessels arrive Sunday with the containers under refrigeration and have a fairly steady refrigeration power demand until the containers begin to be moved off the vessel. This begins on Monday morning at 8:00 a.m. Thus, by 9:00 a.m. the load is lower and so on. There is a short break between 3:00 a.m. and 8:00 a.m. Tuesday morning after which the unloading continues until complete. Once the cargo has been unloaded, the ship departs from the POSD for a return trip to Central and/or South America.

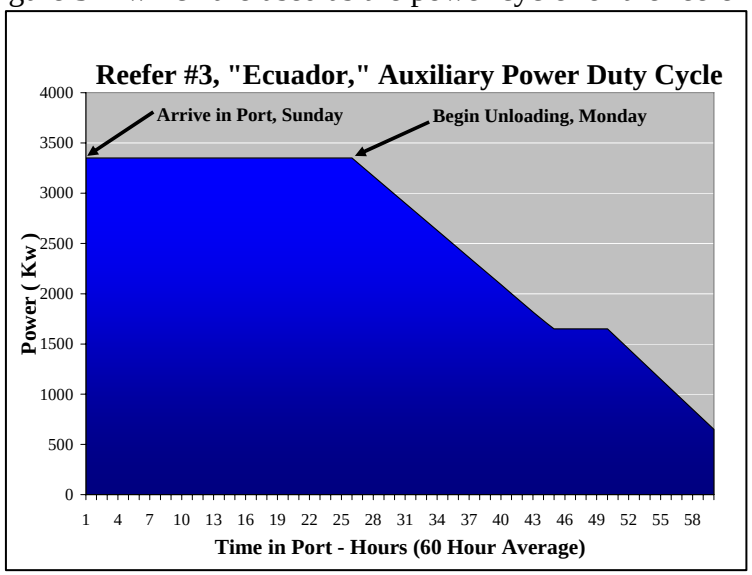

Figure 3-1: Power Cycle for Reefers

3.4 Dole Vessel Emissions

The Dole vessels use only the auxiliary engines during hotelling. The emissions calculation methodology is similar to the cruise ships. Since the Dole vessels have a consistent schedule, actual data was available for this analysis. An average berthing time of 62.40 hours was used for the emissions calculation. (Please refer to Table 3-1 for the actual berthing hours.)

The average load for the 62.4 hour average visit duration was calculated to be 2,548 kW. This was derived from the actual duty cycle shown in Figure 3-1. These Dole vessels have a unique berthing power cycle, which was described in the previous section. Since actual berthing data was available for the Dole vessels, a load factor was not used. According to Dole ship engineers the cranes can take up to 500kW each (qty 2) when lifting and bow thrusters can take up to 800kW if there is a strong wind. Both of these power demands are variable and not included in the Auxiliary Power Duty cycle or the emission calculations.

According to 2006 data, each Dole vessel will dock approximately 17-18 times in the year of 2007. Please refer to Appendix A for the actual berthing and power cycle data for the Dole vessels. The emission calculation parameters are listed below in Table 3-4.

Table 3-3: Emission Calculation Parameters for Dole Vessels

Vessel	Visits/ Year	Berthing Time (hrs)	Available Shore Power (hrs)	Average Load (kW)	Total Shore Power/ Visit (kW-Hr)	# of Aux Engines	Engine Category (MSD)
Dole Costa Rica	17	62.40	60.40	2,548	153,899.20	6	3
Dole Ecuador	17	62.40	60.40	2,548	153,899.20	6	3
Dole Honduras	18	62.40	60.40	2,548	153,899.20	6	3

Please refer to Table 3-4 & Table 3-5 for annual totals for the Dole vessels.

Table 3-4: Annual Hotelling Emission Reduction Potential for Dole Vessels

Vessel	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Dole Costa Rica	40.05	3.17	1.15	1.21	0.66	5.91
Dole Equador	40.05	3.17	1.15	1.21	0.66	5.91
Dole Honduras	42.41	3.36	1.22	1.28	0.70	6.25

Emissions in tons per year (tpy).

Table 3-5: Summary Emissions for All Dole Vessels

	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Totals Air Emissions	126.57	10.02	3.64	3.82	2.09	18.67
Total Emissions Available for Shore Power (minus hookup time)	122.51	9.69	3.53	3.70	2.03	18.07
% Emissions Reduction Potential	**96.8%**	**96.8%**	**96.8%**	**96.8%**	**96.8%**	**96.8%**

4.0 COLD IRONING COST EFFECTIVENESS

Cold Ironing cost effectiveness is an analysis of the relationship between the costs to implement cold ironing and the NO_X emissions reduced by using the shore power. Typically, the cost effectiveness is expressed in terms of the cost (in dollars) of reducing one ton of NO_X per year. This report uses a 2008 Net Present Value (NPV) analysis with a 5% discount and a 10 year NO_X generation period to generate a relative cost, and to compensate for the fact that capital costs and recurring costs occur at different time periods. In addition, an estimate of the ERC/MERC NPV is made including the possible effect of shore power regulation.

To prepare this Cost Effectiveness NPV analysis, several assumptions are required which can greatly affect the calculated values. Every effort has been made to make these assumptions transparent so that, as additional information becomes available, the impacts can be clearly understood and analyzed. Furthermore, this analysis is intended only to provide a rough estimate with the best information available now and is not a detailed study of this issue.

4.1 Initial Capital Costs

To provide the level of power required at the berthing locations required for shore power, significant electrical improvements are required. Currently, the power infrastructure provided by San Diego Gas & Electric (SDG&E) is not adequate at Pier B to handle the expected loads coming from the Cruise ships. The power availability at the 10th Street Marine Terminal is being studied now by the POSD. SDG&E is working on a separate study of the costs to bring shore power to these facilities. In addition to shore side power capital costs, most of the cruise ships and all of the Dole vessels would require vessel modifications to become shore power capable. The cost of these modifications is referred to as "vessel capital costs." This analysis studies the scenario in which all of the Dole and all of the cruise ship visits will use shore power.

4.1.1 Pier B/Cruise Ship Capital Costs

To bring shore power to the cruise ship terminal at Pier B, significant infrastructure improvements would be required to the downtown SDG&E power system. Pier B would need to be equipped with a power delivery system with hook-ups and transformers, and most of the cruise ships would need to be retrofitted in order to receive shore power.

SDG&E system improvements are under study and a final report is not yet available. The estimate used in this report is $22 million to bring the needed power to Pier B. Large cruise ships typically require 6000-8000 kW of average power demand with some of the larger ones requiring 11,000 kW at peak power (*Ref. 13*). Power demand from the cruise ships is typically during the day, which is typically a high load period for SDG&E. Details of the estimate can be found in the SDG&E report (*Ref. 14*).

Once power is brought to Pier B, installation of the pier shore power system will need to take place. Since cruise ships can only accept shore power on one side and some ships use the port side and some the starboard side, power will need to be provided to both sides of the pier. This report assumes that the current project will bring power to both sides of the pier and that the SDG&E system can power two ships at once. The total cost estimate is $4,075,000 and is based on the work done at the Port of Seattle. Please see Appendix D for a more detail.

Cruise ships are not typically equipped with shore power systems and thus would require a capital equipment cost. Four (4) of the 21 ships visiting the POSD are currently equipped with shore power capability. This study assumes that the remaining 17 ships will be retrofitted to accept shore power at a cost of $600,000 each (*Ref. 4*).

4.1.2 10th Avenue Marine Terminal/ Dole Capital Costs

To bring shore power to the 10th Avenue Marine Terminal significant infrastructure improvements may or may not be required to the SDG&E power system. The 10th Avenue Marine Terminal would need to be equipped with a power delivery system with hook-ups and transformers, and the three Dole vessels would need to be retrofitted in order to receive shore power.

SDG&E system improvements are under study and a final report is not yet available. The estimate used in this report is $10 million to bring the needed power to the 10th Avenue Marine Terminal. The Dole ships require an average power demand of approximately 2,500 kW and a peak power of less than 4MW. Power from the Dole reefers is typically spread out throughout the day and night, but will also require power during peak daytime hours. Details of the estimate can be found in the SDG&E report (*Ref. 14*).

Once power is brought to the 10th Avenue Marine Terminal, installation of the shore power system will need to take place. Since the Dole vessels are all sister ships, it is expected that the power hook-up will be at the same location for all three vessels. This report assumes that the current project will bring power to just one location on the pier and that the SDG&E system will provide power for only one reefer at a time. The total cost estimate is $2,037,500 and is based on the work done at the Port of Seattle. Please see Appendix D for more detail.

The Dole vessels are not equipped with shore power systems and thus would require a capital equipment cost. The cost per ship used for this study is $600,000 plus $100,000 due to the limited electrical infrastructure on this type of vessel.

4.2 Net Recurring Costs

Net recurring costs for Shore Power include the cost of electrical power used minus the fuel cost savings of not running the auxiliary engines. One hour is assumed for connection upon arrival and one hour is assumed to disconnect shore power prior to departure. The remaining time while hotelling is assumed to be time when shore power will be used. The total power demand in kW hours for the year is multiplied by the average electrical rate in $/Kw-hour giving the cost per year for electrical usage. The Dole average rate is lower since the Dole Reefer duty cycle is 24 hrs/day and thus has a significant amount of time using off-peak rates. The Electrical rates and cost calculations are shown in the NPV analysis (Table 4-1). The fuel cost is calculated by multiplying the cost of the fuel per ton by the fuel used annually in tons. The cruise ship and Dole vessels both are currently required to use low sulfur fuel and are assumed to be doing so for this analysis. The current fuel prices and usage numbers are shown in the NPV analysis (Table 4-1).

As expected, recurring energy cost of using electrical shore power is greater than the recurring cost of running the auxiliary engines. The new CARB low sulfur fuel requirement doubles the cost of fuel by requiring a switch from low cost RO to higher cost MGO or MDO. RO fuel is

currently being sold for $330 per metric ton in San Diego with MGO ranging from $649-669 depending on the sulfur content (Jankowich rates 2/21/07). The new fuel requirement has the effect of making the cost of running the auxiliary engines change from approximately 7 cents to 14 cents per kW hour. This rate is still expected to be lower than the SDG&E rate for electrical power.

Table 4-1: Dole NPV Analysis

Dole- 10th Avenue Marine Terminal Shore Power NPV Summary

Calculation Summary		NPV
Total NPV	Capital Costs+ Operating Costs	$16,477,256
Reefer Emission Reductions	Total 10 Yr. NOx Usage in Tons	1225.09
Cost Effectiveness Per Ton of Nox*	Shore Power Costs/ Emission Reductions	$13,450

*Cost effectivness drops to $5700/ton if power is available and SDG&E Costs are $0

			NPV
ERC/MERC Est. Value - No Sunset			$8,750,656
ERC/MERC Est. Value with Sunset			$277,799

Significant Assumptions
1. SDG&E Capital Costs and Power Rates
2. Inflation Rates for Fuel and Power
3. Discount Rate for NPV
4. Jan 1, 2010 Shore Power Start Date

ERC/MERC Assumptions
1. ERC/MERC value = $75,000 per Ton of Nox reduciton
2. 100% of ERC/MERC's are sold in 2010
3. Goods Movement Shore Power Reduction % and Date
4. **POSD meets other CARB requirements in the same category

Yellow boxes are highlighted assumptions

Discount Rate	5.0%
Present Value Year	2008

Shore Power Starts in 2010

Capital Costs ($)			NPV	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Shore Side Capital Costs	SDG&E Cost		$9,523,810		10,000,000											
10th Avenue Terminal Capital Costs	Transformers, Cable Systems, etc..		$1,940,476		2,037,500											
Ship Power Capital Costs- Dole	All Three Vessels		$1,714,286		1,800,000											
Total Capital Costs			$13,178,571													

Annual Operating Costs ($)			NPV	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electrical Cost	Hotelling Electrical Cost		$13,116,215	0	0	1,574,378	1,621,610	1,670,258	1,720,366	1,771,977	1,825,136	1,879,890	1,936,287	1,994,375	2,054,207	
Fuel Cost	Hotelling MGO cost for Auxiliary Engines		$9,817,530	0	0	1,178,427	1,213,780	1,250,194	1,287,699	1,326,330	1,366,120	1,407,104	1,449,317	1,492,797	1,537,580	
Net Cost Increase			$3,298,685													

			Electrical Power Inflation Rate		3.0%											
Electrical Power Cost Analysis	**Average Rate ($/kW-hr)**	**Annual**		**Annual Total Electrical Cost ($)**												
		Usage Kw-Hr/yr.	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
	$0.18	8,004,329	1,440,779	1,484,003	1,528,523	1,574,378	1,621,610	1,670,258	1,720,366	1,771,977	1,825,136	1,879,890	1,936,287	1,994,375	2,054,207	2,115,833

			Fuel Cost Inflation Rate		3.0%											
Fuel Cost Analysis	***Fuel Cost**	**Tons/ Year**		**Annual Total Fuel Cost ($)**												
	$/Ton		**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
MGO, 32 tons/visit (31.0 tons - 58.4 hrs)	669	1612	1,078,428	1,110,781	1,144,104	1,178,427	1,213,780	1,250,194	1,287,699	1,326,330	1,366,120	1,407,104	1,449,317	1,492,797	1,537,580	1,583,708

*Fuel prices as of 2/21/07 Jankovich Co.

Cost per KW-hr using MGO	669	$0.135
Cost per KW-hr using RO	330	$0.066

Reduction Credit Value Estimates	**ERC/MERC NOx Value**	**Tons /Yr.**		**Annual MERC Value if Sold**												
No Sunset- 100% Sold in 2010	($ per Ton per Year- No Sunset)	122.51	**NPV**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Reduction Credits Value A	100,000		$11,667,542			$12,250,919										
Reduction Credits Value B	75,000		$8,750,656			$9,188,189										
Reduction Credits Value C	50,000		$5,833,771			$6,125,459										

Projected Goods Movement Shore Power Requirement % and Year											CARB- 100% Reefer Shore power- more than 12 visits					
Sunset Value Estimates		**Tons/ Yr.**	**NPV**	**Probability of Sale**	**Temporary Value Adjustment**											
	5 Year Life- 100% of Total	122.5	$277,799	0.25	0.2	$291,689			5 yr Sunset							
Total Value Assuming 25% Sold in 2010			$277,799													

Table 4-2: Cruise Ship NPV Analysis

Cruise Ship- Pier B Shore Power NPV Summary

Calculation Summary			NPV
Total NPV	Capital Costs+ Operating Costs		$45,663,920
Cruise Ship Emission Reductions	Total 10 Yr. NOx Reducton in Tons		1970
Cost Effectivness $/Per Ton of NOx	Shore Power Costs/ Emission Reductions		$23,176

			NPV
ERC/MERC Est. Value - No Sunset			$10,502,033
ERC/MERC Est. Value with Sunset			$354,711

Significant Assumptions
1. SDG&E Capital Costs and Power Rates
2. Inflation Rates for Fuel and Power
3. Discount Rate for NPV
4. Jan 1, 2010 Shore Power Start Date
5. Aussmes construction costs are in 2009 dollars

Yellow boxes are highlighted assumptions

ERC/MERC Assumptions
1. ERC/MERC value = $75,000 per Ton of Nox reduciton
2. 100% of ERC/MERC's are sold in 2010
3. Goods Movement Shore Power Reduction % and Date
4. POSD meets other CARB requirements in the same category

Discount Rate	5.0%
Present Value Year	2008

Shore Power Starts in 2015

Capital Costs ($)			**NPV-2008**	**2008**	**2009**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Shore Side Capital Costs	SDG&E Cost		22,000,000	22,000,000											
Pier B Terminal Capital Costs	Transformers, Cable Systems, etc..		4,075,000	4,075,000											
Ship Power Capital Costs	All Cruise Ships not capable		9,600,000	9,600,000											
Total Capital Costs			$35,675,000												

Annual Operating Costs			**NPV-2008**	**2008**	**2009**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Electrical Cost	Hotelling Electrical Cost		$24,478,613	0	0	3,750,023	3,862,523	3,978,399	4,097,751	4,220,683	4,347,304	4,477,723	4,612,055	4,750,416	4,892,929
Fuel Cost	Hotelling MGO cost for Auxiliary Engines		$14,489,693	0	0	2,219,761	2,286,354	2,354,945	2,425,593	2,498,361	2,573,312	2,650,511	2,730,026	2,811,927	2,896,285
Net Cost Increase			$9,988,920												

			Electrical Power Inflation Rate	**3.0%**											
Electrical Power Cost Analysis	**Average Rate ($/kW-hr)**	**Annual**		**Annual Total Electrical Cost ($)**											
		Usage kW-hr/	**2007**	**2008**	**2009**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
	$0.23	12,870,880	2,960,302			3,750,023	3,862,523	3,978,399	4,097,751	4,220,683	4,347,304	4,477,723	4,612,055	4,750,416	4,892,929

			Fuel Cost Inflation Rate	**3.0%**											
Fuel Cost Analysis	***Fuel Cost**	**Tons/ Year**		**Annual Total Fuel Cost ($)**											
	$/Ton		**2007**	**2008**	**2009**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
MGO, 32 tons/visit (31.0 tons - 58.4 hrs)	649	2700	1,752,300			2,219,761	2,286,354	2,354,945	2,425,593	2,498,361	2,573,312	2,650,511	2,730,026	2,811,927	2,896,285

*Fuel prices as of 2/21/07 Jankovich Co.

Cost per KW-hr using MGO	649	$0.136
Cost per KW-hr using RO	330	$0.069

ERC/MERC Value Estimates	**ERC/MERC NOx Value**	**Tons /Yr.**		**Annual ERC/MERC Value if Sold With No Sunset**											
No Sunset- 100% Sold in 2015	($ per Ton per Year- No Sunset)	197.03	**NPV**	**2008**	**2009**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Reduction Credits Value A	100,000		$14,002,710	0	0	19,703,219									
Reduction Credits Value B	75,000		$10,502,033	0	0	14,777,415									
Reduction Credits Value C	50,000		$7,001,355	0	0	9,851,610									

Projected Goods Movement Shore Power Requirement above Implementation Year											3 or more visits CARB - pending regulation				
Sunset Value Estimates		Tons/ Yr.	**NPV**	**2008**	**2009**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Credit Value B	Ships with 3 or more visits	190.38	$0												
Credit Value B	Ships with less than 3 visits	6.7	$354,711	0	0	$499,114							No Sunset		

4.3 ERC/MERC's

The value of emission reduction credits known as either ERC or MERC's can vary significantly by market, type of credit, and the duration of the credit. Stationary source ERC's are considered the most valuable, and are estimated to have a value of between $50,000 and $100,000 per ton per year of NOx for credits with no sunset. This valuation was given to us verbally by the SDAPCD and Cantor Fitzgerald (an air emission trading company). Please note there are very few trades in San Diego County for these credits since the potential to emit must be greater than 50 tons/year of NOx to require offsets for a project. This currently limits the customer base to large construction projects or a power plant or some sort of large industrial operation. MERC's that are permanent and can be converted to ERC's would have a similar value.

ERC's or MERC's with a sunset or expiration date are considerably less valuable, if in fact they can be sold. Customers with long term or permanent emissions will be reluctant to purchase them since they would need to be replaced at the sunset date. CARB is considering shore power regulation which may make some or all of the ERC/MERC's sunset when the regulation takes effect. This further complicates the valuation estimates. This study assumes a low probability of sale and a "temporary life adjustment" for ERC/MERC's that sunset. The values for ERC/MERC's are included in the NPV Analysis spreadsheet.

Non-Sunset ERC/MERC value = ($/ton/yr. NOx) X (Tons of NOx emission reductions)

Sunset ERC/MERC value= (Non-Sunset ERC/ MERC Value) X (probability of sale) X (Temporary Life Adjustment)

While the POSD is going through the application process consideration should be given to also apply for PM (Particulate Matter) credits since San Diego County is close to non-attainment for these pollutants. No significant market for these currently exist since offsets are not required for pollutants that are currently in attainment.

4.4 Cost Effectiveness Analysis

In order to study multiple types of emission sources, regulators at the state and local level often use a cost effectiveness number expressed as the cost per ton of pollutant. This cost effectiveness in this study is NOx and is calculated by the following formula:

Cost Effectiveness NOx = (Total NPV Cost) / (Total NOx emissions)

Both the NPV Cost and the NOx emissions are based on a 10 year life. The NPV cost is outlined in detail in Table 4-1 and 4-2 and includes the capital costs and the net recurring costs discussed above.

5.0 ERC/MERC APPLICATION CRITERIA AND DISCUSSION

To apply for and obtain Emission Reduction Credits (ERCs) or MERCs, there are several complex issues that will need to be addressed. This section of the report discusses some of the elements that should be considered. Some of these issues have been discussed in preliminary meetings with the SDAPCD staff (1/31/07, Mr. Stanley Romelczyk and Mr. Steven Moore), with CARB (1/22/07, Mr. Mike Waugh), and in brief discussions with U.S. EPA (1/9/07, Mr. Matt Haber).

5.1 Emission Reduction Credits vs. Mobile Source Emission Reduction Credits

SDAPCD Rule 26 applies to "stationary source emission reduction credits (ERCs)," whereas Rule 27 applies to MERCs." The definition for "Stationary Source" as provided in SDAPCD Rule 2, Definitions, is:

> "**Stationary Source or Source -** means an emission unit or aggregation of emission units which are located on the same or contiguous properties and which units are under common ownership or entitlement to use. Stationary sources also include those emission units or aggregation of emission units located in the California Coastal Waters."

There is no definition for "Mobile Source." During discussions with the SDAPCD, they commented that there was some question as to whether or not Rule 26 or Rule 27 would apply. They did note that with Rule 27, they would have to develop an "Alternative Mobile Source Emission Reduction Program," with corresponding CEQA evaluation, for this specific application prior to issuing MERCs.

One of the other differences between the two rules is the definition of "Permanent."

- Rule 26 defines "Permanent" as: "'"**Permanent**" means federally enforceable and which will exist for an unlimited period of time."
- Rule 27 defines "Permanent" as: "**"Permanent"** means enduring and enforceable for the duration of the credit life."

However, Rule 26 does provide for Temporary Actual Emission Reductions, in which "'Temporary' means federally enforceable, existing and valid for a specified limited period of time." The ERCs issued from such temporary reductions would be "identified as temporary and shall include a specific date beyond which the reductions are no longer valid." The ERCs issued, however, may be issued as class A ERCs, with a limited life specified on the ERC documentation.

Class A ERCs with a limited life would have a much smaller market for sale as they can not be used for long term projects. They would only be useful for projects with a limited life requiring offsets, for example, ocean dredging operations. This is the same as for the use of MERCs with a limited life. The difference between MERCs and ERCs that are not time limited is that EPA and CARB approval is required for MERCs to be used as ERCs to offset a stationary source project. Thus, ERCs without time limits are more broadly useful and marketable.

5.2 Ownership of the Reduction Credits

One of the first questions raised by the SDAPCD staff was the identification of the "owner" of any reduction credits generated. This is a significant question given that the emissions are currently generated by a number of various ships, under different ownerships, and contractual arrangements. If the ships are shore powered, what will define the ownership of the emissions reduced? Specifically, if the application is made by the POSD, what gives ownership of the reductions to the Port Authority, such that the SDAPCD may issue to the Port legal entitlement to the credits generated? In an application for emission reduction credits, the Port would need to show legal entitlement.

5.3 Emission Reduction Credit Criteria

5.3.1 Real

The first criteria that will need to be demonstrated in an application for ERC/MERCs will be that the emissions to be reduced are "real." Each ERC/MERC rule provides a definition of "Real":

- Rule 27 defines "Real" as "…actually occurring and not artificially devised."
- Rule 26 defines "Real" as "…actually occurring and which will not be replaced, displaced or transferred to another emission unit at the same or other stationary source within San Diego County, as determined by the Air Pollution Control Officer."

Rule 26 further defines "Actual Emission Reductions" as emission reductions which are real, surplus, enforceable, federally enforceable, and quantifiable and may be permanent or temporary in duration. Actual emission reductions shall be calculated pursuant to Section (d) of this rule. All actual emission reductions must be federally enforceable by conditions in the permit or ERC.

To demonstrate that the emissions from the Cruise Terminal and Pier B the 10th Avenue Marine Terminal are "real" emission calculations, with actual docking records for the past two years, should be provided. These "Actual Emissions" would be quantified per the requirements of Rule 26 (d), "Emission Reductions Calculations."

5.3.2 Surplus

To receive credit for emission reductions, the reductions must be in excess of emission control measures that are already required, or will be required, for that source.

- Rule 26 defines "Surplus" as "…any emission reduction which, as determined by the Air Pollution Control Officer, is in excess of… Any standard or other requirement provided for in the SIP, including any revisions approved by the federal EPA through rulemaking under Title I of the federal Clean Air Act;… Any stationary source emission reduction measure noticed for workshop by the District prior to receipt of the application to bank the emission reductions…"
- Rule 27 defines "Surplus" as "…in excess of any emission reduction which is… Required by any adopted federal, state, or District law, regulation, rule, agreement,

or order; or… Attributed to a proposed Mobile Source Control Measure noticed for workshop in the District…"

Although these definitions do not explicitly include CARB rules that having been noticed for workshop, these may reasonably be included as have been mentioned by staff at SDAPCD, CARB, and EPA.

In this case, the two "Surplus" elements that need to be incorporated into the emissions considered for reduction:

- The new CARB low sulfur fuel requirements (Regulation for Auxiliary Diesel Engines and Diesel-Electric Engines Operated on Ocean-Going Vessels within California Waters) that just took effect on January 1, 2007 and that have been included in the emissions calculated in this report; and
- The potential "Shore Power for Ocean-Going Vessels" requirements that CARB has noticed for workshop.

5.3.3 Quantifiable

To receive stationary or mobile source emission reduction credits, the emissions must be quantified in a manner that is reliable, accurate, and verifiable as determined by the SDAPCD, CARB, and EPA.

- Rule 26 defines "Quantifiable" as "…a reliable basis to estimate emission reductions in terms of both their amounts and characteristics can be established, as determined by the Air Pollution Control Officer. Quantification may be based upon emission factors, stack tests, monitored values, operating rates and averaging times, process or production inputs, mass balances or other reasonable measurement or estimating practices."
- Rule 27 defines "Quantifiable" as "…a reliable and accurate basis for calculating the amount, rate, nature, and characteristics of an emission reduction can be established, considering United States Environmental Protection Agency (EPA), ARB, and District policies and procedures."

In this report, EPA emission factors for ship auxiliary engines have been used. These same factors would be used in an ERC/MERC application. In the past, the SDAPCD has required emissions testing to determine MERC reduction credits. If the reviewing agencies required source testing in this case, if could increase the cost and time required to obtain credits.

5.3.4 Enforceable

One of the most important issues to resolve prior to issuance of credits is the method of enforceability to ensure that the terms of the credit will actually be met, that there will be accurate records to demonstrate compliance, and that there will be no "backsliding" to ensure that the emissions generated are real, permanent (or temporary, as stated), and surplus.

- Rule 26 defines "Enforceable" as "…capable of being enforced by the District, including through either the SIP or inclusion of conditions on an Authority to Construct, Permit to Operate, Determination of Compliance, or ERC certificate."
- Rule 27 defines "Enforceable" as "…can be enforced by the District through conditions of a MERC certificate established pursuant to Subsection (c)(4)(i)..." (where (c)(4)(i) specifies: "Issuance or amendment of MERC Certificate")

In this case, it is anticipated that a framework of enforceability should be proposed in the application which would then be incorporated into the conditions explicitly stated on the ERCs or MERCs to be issued. These terms of enforcement may include recordkeeping and reporting to the SDAPCD to demonstrate that the emission reductions are achieved as stated.

5.3.5 Permanent

Whether the ERCs or MERCs are temporary or permanent, there needs to be assurance that the reductions are achieved as stated and that there is no "backsliding." For example, if the issuance of ERC/MERCs is based upon three Dole ships (of a specific size and power demand) using shore power within 1 hour of docking for the next 15 years, then there needs to be a demonstration of assurance that those ships (or their equivalent) will continue to dock at POSD and shore power within 1 hour for 15 years as stated.

- Rule 26 defines "Permanent" as "…federally enforceable and which will exist for an unlimited period of time."
- Rule 27 defines "Permanent" as "…enduring and enforceable for the duration of the credit life."

While rule 27 does not site a requirement to be "federally enforceable," this would be required for the credits to be used for New Source Review offsets, as were prior "PG&E" NOx offsets. Rule 26 does require federal enforceability, and is defined as:

> "'Federally Enforceable' means, for purposes of creating, banking and/or using ERCs, capable of being enforced by the federal Environmental Protection Agency (EPA) including through either the SIP or terms and conditions of a Permit to Operate or an ERC certificate that are necessary to ensure compliance with Rules 26.0 et seq., and to ensure the validity of the emission reduction, or through terms and conditions on an Authority to Construct or Permit to Operate or Determination of Compliance as they apply to the creation of emissions reductions eligible for banking under Rules 26.0 et seq. This does not preclude enforcement by the Air Pollution Control Officer.

5.4 ERC/MERC Development and Implementation Timeline

In the application, the timeline for the installation of all of the infrastructure and equipment will need to be defined along with the possible implementation schedule required in CARB's Shore Power rule. The timing of when the reductions will actually occur, along with the timing of when the required reductions are mandated, will then define the "lifetime" of the ERCs or MERCs. In addition, since CARB's Shore Power rule has not yet been adopted, there is also a possibility that it may not be, or that adoption will be delayed past the November 2007 timetable.

An additional uncertainty is the length of time that may be required for the regulatory authorities (SDAPCD, CARB, and EPA) to develop any required programs, California Environmental Quality Act, or other documents as well as discussions, agreements, and/or public notice required to issue the ERC/MERCs.

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APPENDIX A – CRUISE SHIP SCHEDULE

2007 Cruise Ship Schedule

VESSEL NAME	LINE	DATE	BERTH
CARNIVAL SPIRIT	CARNIVAL	01/02/07	B-1
CRYSTAL SYMPHONY	CRYSTAL	01/03/07	B-1
ZAANDAM	HAL	01/05/07	B-1
MONARCH OF THE SEAS	RCCL	01/05/07	B-5
OOSTERDAM	HAL	01/06/07	B-1
MERCURY	CELEBRITY	01/08/07	B-1
MONARCH OF THE SEAS	RCCL	01/09/07	B-1
CARNIVAL SPIRIT	CARNIVAL	01/10/07	B-1
OOSTERDAM	HAL	01/13/07	B-1
MONARCH OF THE SEAS	RCCL	01/16/07	B-1
CARNIVAL SPIRIT	CARNIVAL	01/18/07	B-1
MERCURY	CELEBRITY	01/19/07	B-1
OOSTERDAM	HAL	01/20/07	B-1
ZAANDAM	HAL	01/20/07	B-1
RYNDAM	HAL	01/22/07	B-1
MONARCH OF THE SEAS	RCCL	01/23/07	B-5
CARNIVAL SPIRIT	CARNIVAL	01/26/07	B-1
OOSTERDAM	HAL	01/27/07	B-1
MERCURY	CELEBRITY	01/29/07	B-1
MONARCH OF THE SEAS	RCCL	01/30/07	B-1
OOSTERDAM	HAL	02/03/07	B-1
CARNIVAL SPIRIT	CARNIVAL	02/03/07	B-5
ZAANDAM	HAL	02/04/07	B-1
MONARCH OF THE SEAS	RCCL	02/06/07	B-1
MERCURY	CELEBRITY	02/09/07	B-1
OOSTERDAM	HAL	02/10/07	B-1
CARNIVAL SPIRIT	CARNIVAL	02/11/07	B-1
MONARCH OF THE SEAS	RCCL	02/13/07	B-5
VOLENDAM	HAL	02/16/07	B-1
OOSTERDAM	HAL	02/17/07	B-1
MERCURY	CELEBRITY	02/18/07	B-1
ZAANDAM	HAL	02/19/07	B-1
CARNIVAL SPIRIT	CARNIVAL	02/19/07	B-5
MONARCH OF THE SEAS	RCCL	02/20/07	B-1
RYNDAM	HAL	02/21/07	B-1
OOSTERDAM	HAL	02/24/07	B-1
CARNIVAL SPIRIT	CARNIVAL	02/27/07	B-1
MONARCH OF THE SEAS	RCCL	02/27/07	B-5
RYNDAM	HAL	03/03/07	B-1
OOSTERDAM	HAL	03/03/07	B-1
ZAANDAM	HAL	03/06/07	B-1
MONARCH OF THE SEAS	RCCL	03/06/07	B-5
CARNIVAL SPIRIT	CARNIVAL	03/07/07	B-1
OOSTERDAM	HAL	03/10/07	B-1
RYNDAM	HAL	03/13-15/07	B-1
MONARCH OF THE SEAS	RCCL	03/13/07	B-5
CARNIVAL SPIRIT	CARNIVAL	03/15/07	B-1
OOSTERDAM	HAL	03/17/07	B-1
MERCURY	CELEBRITY	03/18/07	B-1
MONARCH OF THE SEAS	RCCL	03/20/07	B-1
ZAANDAM	HAL	03/21/07	B-1
CARNIVAL SPIRIT	CARNIVAL	03/23/07	B-1
RYNDAM	HAL	03/23/07	B-1
OOSTERDAM	HAL	03/24/07	B-1
MERCURY	CELEBRITY	03/26/07	B-4
MONARCH OF THE SEAS	RCCL	03/27/07	B-1
CARNIVAL SPIRIT	CARNIVAL	03/31/07	B-4
OOSTERDAM	HAL	03/31/07	B-1
RYNDAM	HAL	04/02/07	B-5

VESSEL NAME	LINE	DATE	BERTH
MONARCH OF THE SEAS	RCCL	04/03/07	B-1
ZAANDAM	HAL	04/05/07	B-1
MERCURY	CELEBRITY	04/06/07	B-1
OOSTERDAM	HAL	04/07/07	B-1
CARNIVAL SPIRIT	CARNIVAL	04/08/07	B-1
GTS INFINITY	CELEBRITY	04/08/07	B-4
MONARCH OF THE SEAS	RCCL	04/10/07	B-5
RYNDAM	HAL	04/12/07	B-5
MERCURY	CELEBRITY	04/13/07	B-1
OOSTERDAM	HAL	04/14/07	B-1
CARNIVAL SPIRIT	CARNIVAL	04/15/07	B-4
ZAANDAM	HAL	04/15/07	B-1
MONARCH OF THE SEAS	RCCL	04/17/07	B-1
OOSTERDAM	HAL	04/21/07	B-1
GTS INFINITY	CELEBRITY	04/22/07	B-4
RYNDAM	HAL	04/22/07	B-2
MONARCH OF THE SEAS	RCCL	04/24/07	B-1
MERCURY	CELEBRITY	04/27/07	B-1
RADIANCE OF THE SEAS	RCCL	04/28/07	B-4
MONARCH OF THE SEAS	RCCL	05/01/07	B-1
RYNDAM	HAL	05/02/07	B-1
SUN PRINCESS	PRINCESS	05/03/07	B-1
DIAMOND PRINCESS	PRINCESS	05/06/07	B-1
GTS INFINITY	CELEBRITY	05/06/07	B-1
VOLENDAM	HAL	05/07/07	B-1
ZUIDERDAM	HAL	05/08/07	B-1
MONARCH OF THE SEAS	RCCL	05/08/07	B-4
RADIANCE OF THE SEAS	RCCL	05/12/07	B-1
EXPLORER	V SHIPS	05/14/07	B-5
MONARCH OF THE SEAS	RCCL	05/15/07	B-1
MONARCH OF THE SEAS	RCCL	05/22/07	B-1
ELATION	CARNIVAL	05/27/07	B-1
MONARCH OF THE SEAS	RCCL	05/29/07	B-1
ELATION	CARNIVAL	06/02/07	B-1
MONARCH OF THE SEAS	RCCL	06/05/07	B-1
ELATION	CARNIVAL	06/07/07	B-1
EXPLORER	V SHIPS	06/11/07	By-2
ELATION	CARNIVAL	06/11/07	B-1
MONARCH OF THE SEAS	RCCL	06/12/07	B-1
ELATION	CARNIVAL	06/16/07	B-1
MONARCH OF THE SEAS	RCCL	06/19/07	B-1
ELATION	CARNIVAL	06/21/07	B-1
ELATION	CARNIVAL	06/25/07	B-1
MONARCH OF THE SEAS	RCCL	06/26/07	B-1
ELATION	CARNIVAL	06/30/07	B-1
MONARCH OF THE SEAS	RCCL	07/03/07	B-1
ELATION	CARNIVAL	07/15/07	B-1
ELATION	CARNIVAL	07/09/07	B-1
MONARCH OF THE SEAS	RCCL	07/10/07	B-1
ELATION	CARNIVAL	07/14/07	B-1
MONARCH OF THE SEAS	RCCL	07/17/07	B-1
ELATION	CARNIVAL	07/19/07	B-1
ELATION	CARNIVAL	07/23/07	B-1
MONARCH OF THE SEAS	RCCL	07/24/07	B-1
ELATION	CARNIVAL	07/28/07	B-1
MONARCH OF THE SEAS	RCCL	07/31/07	B-1
ELATION	CARNIVAL	08/02/07	B-1
ELATION	CARNIVAL	08/06/07	B-1
MONARCH OF THE SEAS	RCCL	08/07/07	B-1

2007 Cruise Ship Schedule

VESSEL NAME	LINE	DATE	BERTH
ELATION	CARNIVAL	08/11/07	B-1
MONARCH OF THE SEAS	RCCL	08/14/07	B-1
ELATION	CARNIVAL	08/16/07	B-1
MONARCH OF THE SEAS	RCCL	08/21/07	B-1
ELATION	CARNIVAL	08/16/07	B-1
ELATION	CARNIVAL	08/20/07	B-1
EXPLORER	V SHIPS	08/21/07	By-2
ELATION	CARNIVAL	08/25/07	B-1
MONARCH OF THE SEAS	RCCL	08/28/07	B-1
ELATION	CARNIVAL	08/30/07	B-1
ELATION	CARNIVAL	09/03/07	B-1
MONARCH OF THE SEAS	RCCL	09/04/07	B-1
ELATION	CARNIVAL	09/08/07	B-1
MONARCH OF THE SEAS	RCCL	09/11/07	B-1
ELATION	CARNIVAL	09/13/07	B-1
ELATION	CARNIVAL	09/17/07	B-1
MONARCH OF THE SEAS	RCCL	09/18/07	B-5
RHAPSODY OF THE SEAS	RCCL	09/18/07	B-1
DAWN PRINCESS	PRINCESS	09/19/07	B-1
ELATION	CARNIVAL	09/22/07	B-1
DAWN PRINCESS	PRINCESS	09/23/07	B-1
MONARCH OF THE SEAS	RCCL	09/25/07	B-1
ELATION	CARNIVAL	09/27/07	B-1
SUMMIT	CELEBRITY	09/28/07	B-1
DAWN PRINCESS	PRINCESS	09/30/07	B-1
ZAANDAM	HAL	10/01/07	B-1
ELATION	CARNIVAL	10/01/07	B-4
VOLENDAM	HAL	10/02/07	B-1
MONARCH OF THE SEAS	RCCL	10/02/07	B-5
SERENADE OF THE SEAS	RCCL	10/05/07	B-1
ELATION	CARNIVAL	10/05/07	B-4
OOSTERDAM	HAL	10/06/07	B-1
DAWN PRINCESS	PRINCESS	10/07/07	B-1
MONARCH OF THE SEAS	RCCL	10/09/07	B-1
ELATION	CARNIVAL	10/09/07	B-4
NORWEGIAN SUN	NCL	10/09/07	BY-5
RYNDAM	HAL	10/11/07	B-1
ZAANDAM	HAL	10/11/07	B-1
SUMMIT	CELEBRITY	10/12/07	B-1
OOSTERDAM	HAL	10/13/07	B-1
CARNIVAL SPIRIT	CARNIVAL	10/13/07	B-5
DAWN PRINCESS	PRINCESS	10/13/07	BY-2
ELATION	CARNIVAL	10/14/07	B-1
MONARCH OF THE SEAS	RCCL	10/16/07	B-1
ELATION	CARNIVAL	10/19/07	B-1
OOSTERDAM	HAL	10/20/07	B-1
SERENADE OF THE SEAS	RCCL	10/20/07	B-5
CARNIVAL SPIRIT	CARNIVAL	10/21/07	B-5
RYNDAM	HAL	10/21/07	B-1
DAWN PRINCESS	PRINCESS	10/21/07	BY-5
MONARCH OF THE SEAS	RCCL	10/23/07	B-5
ELATION	CARNIVAL	10/25/07	B-4
ZAANDAM	HAL	10/26/07	B-5
SUMMIT	CELEBRITY	10/26/07	B-1
OOSTERDAM	HAL	10/27/07	B-1
SERENADE OF THE SEAS	RCCL	10/27/07	B-5
GTS INFINITY	CELEBRITY	10/28/07	B-1
DAWN PRINCESS	PRINCESS	10/28/07	B-5
CARNIVAL SPIRIT	CARNIVAL	10/29/07	B-1

VESSEL NAME	LINE	DATE	BERTH
ELATION	CARNIVAL	10/29/07	B-4
MONARCH OF THE SEAS	RCCL	10/30/07	B-5
RYNDAM	HAL	10/31/07	B-1
OOSTERDAM	HAL	11/03/07	B-1
ELATION	CARNIVAL	11/03/07	B-4
ZAANDAM	HAL	11/05/07	B-1
CARNIVAL SPIRIT	CARNIVAL	11/06/07	B-1
MONARCH OF THE SEAS	RCCL	11/06/07	B-5
ELATION	CARNIVAL	11/08/07	B=1
SUMMIT	CELEBRITY	11/09/07	B-1
OOSTERDAM	HAL	11/10/07	B-5
RYNDAM	HAL	11/10/07	B-1
DAWN PRINCESS	PRINCESS	10/11/07	B-1
MERCURY	CELEBRITY	11/12/07	B-1
ELATION	CARNIVAL	11/12/07	B-4
MONARCH OF THE SEAS	RCCL	11/13/07	B-5
CARNIVAL SPIRIT	CARNIVAL	11/14/07	B-1
OOSTERDAM	HAL	11/17/07	B-1
ELATION	CARNIVAL	11/17/07	B-4
DAWN PRINCESS	PRINCESS	10/18/07	B-1
ZAANDAM	HAL	11/20/07	B-1
RYNDAM	HAL	11/20/07	B-5
MONARCH OF THE SEAS	RCCL	11/20/07	BY-5
CARNIVAL SPIRIT	CARNIVAL	11/22/07	B-1
ELATION	CARNIVAL	11/22/07	B-4
SUMMIT	CELEBRITY	11/23/07	B-1
AMSTERDAM	HAL	11/24/07	B-5
OOSTERDAM	HAL	11/24/07	B-1
DAWN PRINCESS	PRINCESS	11/25/07	B-1
ELATION	CARNIVAL	11/26/07	B-1
MONARCH OF THE SEAS	RCCL	11/27/07	B-5
CARNIVAL SPIRIT	CARNIVAL	11/30/07	B-1
OOSTERDAM	HAL	12/01/07	B-1
ELATION	CARNIVAL	12/01/07	B-1
MONARCH OF THE SEAS	RCCL	12/04/07	B-5
ZAANDAM	HAL	12/05/07	B-1
ELATION	CARNIVAL	12/06/07	B-1
CARNIVAL SPIRIT	CARNIVAL	12/08/07	B-5
OOSTERDAM	HAL	12/08/07	B-5
SILVER SHADOW	SILVER	12/08/07	BY-5
DAWN PRINCESS	PRINCESS	12/09/07	B-1
ELATION	CARNIVAL	12/10/07	B-4
MONARCH OF THE SEAS	RCCL	12/11/07	B-5
RYNDAM	HAL	12/13/07	B-1
OOSTERDAM	HAL	12/15/07	B-1
ELATION	CARNIVAL	12/15/07	B-4
CARNIVAL SPIRIT	CARNIVAL	12/16/07	B-1
DAWN PRINCESS	PRINCESS	12/16/07	B-5
MONARCH OF THE SEAS	RCCL	12/18/07	B-5
ZAANDAM	HAL	12/20/07	B-1
ELATION	CARNIVAL	12/20/07	B-4
OOSTERDAM	HAL	12/22/07	B-1
CRYSTAL SYMPHONY	CRYSTAL	12/22/07	B-5
RYNDAM	HAL	12/23/07	B-1
DAWN PRINCESS	PRINCESS	12/23/07	B-5
CARNIVAL SPIRIT	CARNIVAL	12/24/07	B-1
ELATION	CARNIVAL	12/24/07	B-4
OOSTERDAM	HAL	12/29/07	B-1
ELATION	CARNIVAL	12/29/07	B-4
RYNDAM	HAL	12/30/07	B-1
DAWN PRINCESS	PRINCESS	12/20/07	B-5

APPENDIX B - MAPS

San Diego Bay Vicinity Map

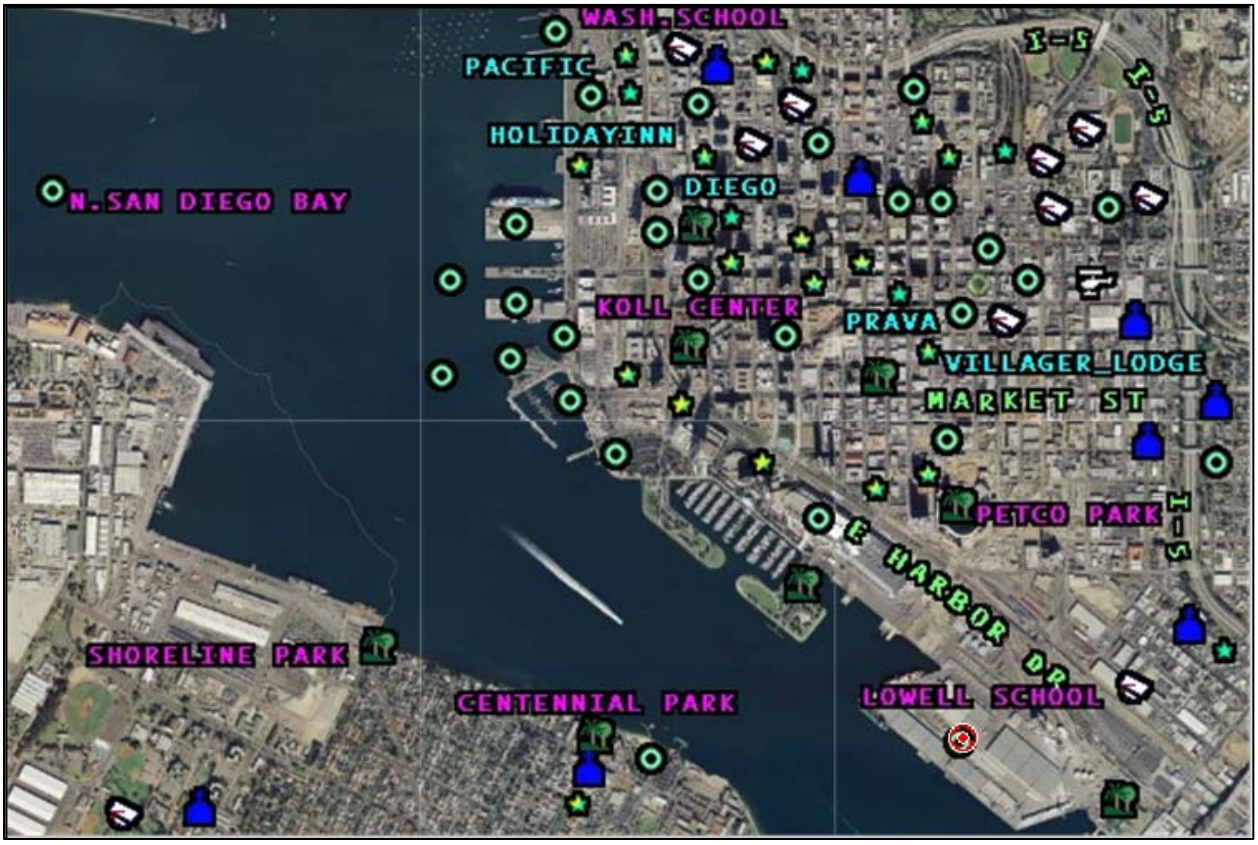

Photo Taken from www.USGS.org

San Diego Bay Arial Map

Photo taken from www.USGS.org

Map of San Diego Bay

Photo taken from www.portofsandiego.org

APPENDIX C – EMISSIONS CALCULATIONS

2007 Vessel Info

Total Air Emissions with Marine Gasoline Oil

Total Air Emissions with Residual Oil

Potential Air Emissions Reduction with Marine Gasoline Oil

Potential Air Emissions Reduction with Residual Oil

Emissions from Power Generation

Summary Sheet

2007 Vessel Info

VESSEL NAME	LINE	Visits/ Year	Berthing Duration	Available Shore Power Duration	Ave. Aux. Total Power	Load Factor	Average Power Load	Power per Visit	Passenger Counts
			(hrs.)	(hrs.)	(kW)		(kW)	(kW-hr)	
MONARCH OF THE SEAS	RCCL	51	9.25	7.25	11,000	0.64	7,040	51,040	2,774
ELATION	CARNIVAL	48	10	8	11,000	0.64	7,040	56,320	2,200
OOSTERDAM**	HAL	29	11	9	11,000	0.64	7,040	63,360	1,848
CARNIVAL SPIRIT	CARNIVAL	24	11.5	9.5	11,000	0.64	7,040	66,880	2,300
RYNDAM	HAL	17	10.5	8.5	5,500	0.64	3,520	29,920	1,169
ZAANDAM	HAL	15	10.5	8.5	11,000	0.64	7,040	59,840	1,440
DAWN PRINCESS**	PRINCESS	14	11	9	11,000	0.64	7,040	63,360	1,950
MERCURY	CELEBRITY	11	8	6	11,000	0.64	7,040	42,240	1,870
SUMMIT	CELEBRITY	5	10	8	11,000	0.64	7,040	56,320	1,935
SERENADE OF THE SEAS	RCCL	3	13.5	11.5	11,000	0.64	7,040	80,960	2,501
GTS INFINITY	CELEBRITY	4	10	8	11,000	0.64	7,040	56,320	2,069
VOLENDAM	HAL	3	10.5	8.5	11,000	0.64	7,040	59,840	1,440
CRYSTAL SYMPHONY	CRYSTAL	2	3	1	5,500	0.64	3,520	3,520	940
RADIANCE OF THE SEAS	RCCL	2	10.5	8.5	11,000	0.64	7,040	59,840	1,950
SILVER SHADOW	SILVER	1	11	9	2,750	0.64	1,760	15,840	382
RHAPSODY OF THE SEAS	RCCL	1	10	8	11,000	0.64	7,040	56,320	1,890
DIAMOND PRINCESS**	PRINCESS	1	11.5	9.5	11,000	0.64	7,040	66,880	2,670
SUN PRINCESS**	PRINCESS	1	11.5	9.5	11,000	0.64	7,040	66,880	1,950
AMSTERDAM	HAL	1	10.5	8.5	11,000	0.64	7,040	59,840	1,380
NORWEGIAN SUN	NCL	1	10	8	5,500	0.64	3,520	28,160	1,200
ZUIDERDAM	HAL	1	10	8	2,750	0.64	1,760	14,080	729
	Total	**235**							
	Average		**10.2**	**8.2**	**9,429**		**6,034**	**50,370**	

** Cruise Ships Capable of Shore Power

Total Visits	**235**
Shore Power Capable Visits	**45**
% of Total Visits with Shore Power Capability	**19.15%**

Vessel	Visits/ Year	Berthing Time	Shore Power	Average Load	Total Shore Power/ Visit	# of Aux engines	Engine Category (Medium Speed)
		(hrs.)	(hrs.)	(kW)	(kW-hr)		
Dole Costa Rica	17	62.40	60.40	2,548	153,899	6	3
Dole Ecuador	17	62.40	60.40	2,548	153,899	6	3
Dole Honduras	18	62.40	60.40	2,548	153,899	6	3

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Total Air Emissions with Marine Gasoline Oil

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
MONARCH OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	1.00	0.08	0.03	0.03	0.02	0.15	50.84	4.02	1.46	1.54	0.84	7.50
ELATION	13.9	1.1	0.4	0.42	0.23	2.05	1.08	0.09	0.03	0.03	0.02	0.16	51.73	4.09	1.49	1.56	0.86	7.63
OOSTERDAM**	13.9	1.1	0.4	0.42	0.23	2.05	1.19	0.09	0.03	0.04	0.02	0.17	34.38	2.72	0.99	1.04	0.57	5.07
CARNIVAL SPIRIT	13.9	1.1	0.4	0.42	0.23	2.05	1.24	0.10	0.04	0.04	0.02	0.18	29.74	2.35	0.86	0.90	0.49	4.39
RYNDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.57	0.04	0.02	0.02	0.01	0.08	9.62	0.76	0.28	0.29	0.16	1.42
ZAANDAM	13.9	1.1	0.4	0.42	0.23	2.05	1.13	0.09	0.03	0.03	0.02	0.17	16.97	1.34	0.49	0.51	0.28	2.50
DAWN PRINCESS**	13.9	1.1	0.4	0.42	0.23	2.05	1.19	0.09	0.03	0.04	0.02	0.17	16.60	1.31	0.48	0.50	0.27	2.45
MERCURY	13.9	1.1	0.4	0.42	0.23	2.05	0.86	0.07	0.02	0.03	0.01	0.13	9.48	0.75	0.27	0.29	0.16	1.40
SUMMIT	13.9	1.1	0.4	0.42	0.23	2.05	1.08	0.09	0.03	0.03	0.02	0.16	5.39	0.43	0.16	0.16	0.09	0.79
SERENADE OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	1.45	0.12	0.04	0.04	0.02	0.21	4.36	0.35	0.13	0.13	0.07	0.64
GTS INFINITY	13.9	1.1	0.4	0.42	0.23	2.05	1.08	0.09	0.03	0.03	0.02	0.16	4.31	0.34	0.12	0.13	0.07	0.64
VOLENDAM	13.9	1.1	0.4	0.42	0.23	2.05	1.13	0.09	0.03	0.03	0.02	0.17	3.39	0.27	0.10	0.10	0.06	0.50
CRYSTAL SYMPHONY	13.9	1.1	0.4	0.42	0.23	2.05	0.16	0.01	0.00	0.00	0.00	0.02	0.32	0.03	0.01	0.01	0.01	0.05
RADIANCE OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	1.13	0.09	0.03	0.03	0.02	0.17	2.26	0.18	0.07	0.07	0.04	0.33
SILVER SHADOW	13.9	1.1	0.4	0.42	0.23	2.05	0.30	0.02	0.01	0.01	0.00	0.04	0.30	0.02	0.01	0.01	0.00	0.04
RHAPSODY OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	1.08	0.09	0.03	0.03	0.02	0.16	1.08	0.09	0.03	0.03	0.02	0.16
DIAMOND PRINCESS**	13.9	1.1	0.4	0.42	0.23	2.05	1.24	0.10	0.04	0.04	0.02	0.18	1.24	0.10	0.04	0.04	0.02	0.18
SUN PRINCESS**	13.9	1.1	0.4	0.42	0.23	2.05	1.24	0.10	0.04	0.04	0.02	0.18	1.24	0.10	0.04	0.04	0.02	0.18
AMSTERDAM	13.9	1.1	0.4	0.42	0.23	2.05	1.13	0.09	0.03	0.03	0.02	0.17	1.13	0.09	0.03	0.03	0.02	0.17
NORWEGIAN SUN	13.9	1.1	0.4	0.42	0.23	2.05	0.54	0.04	0.02	0.02	0.01	0.08	0.54	0.04	0.02	0.02	0.01	0.08
ZUIDERDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.27	0.02	0.01	0.01	0.00	0.04	0.27	0.02	0.01	0.01	0.00	0.04
												TOTAL:	**245.21**	**19.40**	**7.06**	**7.41**	**4.06**	**36.16**

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
Dole Costa Rica	13.9	1.1	0.4	0.42	0.23	2.05	2.43	0.19	0.07	0.07	0.04	0.36	41.38	3.27	1.19	1.25	0.68	6.10
Dole Ecuador	13.9	1.1	0.4	0.42	0.23	2.05	2.43	0.19	0.07	0.07	0.04	0.36	41.38	3.27	1.19	1.25	0.68	6.10
Dole Honduras	13.9	1.1	0.4	0.42	0.23	2.05	2.43	0.19	0.07	0.07	0.04	0.36	43.81	3.47	1.26	1.32	0.72	6.46
												TOTAL:	**126.57**	**10.02**	**3.64**	**3.82**	**2.09**	**18.67**

* Assumptions:
- Main Engines off during hoteling (except Diesel-Electric)
- All Engines are Cat. 3 burning MGO
- Ave. Sulfur Content 0.5% MGO
- Emission Factors US EPA Jan 06 Report

** Cruise Ships Capable of Shore Power

Prepared by:

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Total Air Emissions with Residual Oil

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
MONARCH OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	1.05	0.08	0.03	0.08	0.08	0.80	53.77	4.02	1.46	4.17	4.02	40.60
ELATION	14.7	1.1	0.4	1.14	1.1	11.1	1.14	0.09	0.03	0.09	0.09	0.86	54.71	4.09	1.49	4.24	4.09	41.31
OOSTERDAM**	14.7	1.1	0.4	1.14	1.1	11.1	1.25	0.09	0.03	0.10	0.09	0.95	36.36	2.72	0.99	2.82	2.72	27.45
CARNIVAL SPIRIT	14.7	1.1	0.4	1.14	1.1	11.1	1.31	0.10	0.04	0.10	0.10	0.99	31.46	2.35	0.86	2.44	2.35	23.75
RYNDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.60	0.04	0.02	0.05	0.04	0.45	10.17	0.76	0.28	0.79	0.76	7.68
ZAANDAM	14.7	1.1	0.4	1.14	1.1	11.1	1.20	0.09	0.03	0.09	0.09	0.90	17.95	1.34	0.49	1.39	1.34	13.55
DAWN PRINCESS**	14.7	1.1	0.4	1.14	1.1	11.1	1.25	0.09	0.03	0.10	0.09	0.95	17.55	1.31	0.48	1.36	1.31	13.25
MERCURY	14.7	1.1	0.4	1.14	1.1	11.1	0.91	0.07	0.02	0.07	0.07	0.69	10.03	0.75	0.27	0.78	0.75	7.57
SUMMIT	14.7	1.1	0.4	1.14	1.1	11.1	1.14	0.09	0.03	0.09	0.09	0.86	5.70	0.43	0.16	0.44	0.43	4.30
SERENADE OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	1.54	0.12	0.04	0.12	0.12	1.16	4.62	0.35	0.13	0.36	0.35	3.49
GTS INFINITY	14.7	1.1	0.4	1.14	1.1	11.1	1.14	0.09	0.03	0.09	0.09	0.86	4.56	0.34	0.12	0.35	0.34	3.44
VOLENDAM	14.7	1.1	0.4	1.14	1.1	11.1	1.20	0.09	0.03	0.09	0.09	0.90	3.59	0.27	0.10	0.28	0.27	2.71
CRYSTAL SYMPHONY	14.7	1.1	0.4	1.14	1.1	11.1	0.17	0.01	0.00	0.01	0.01	0.13	0.34	0.03	0.01	0.03	0.03	0.26
RADIANCE OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	1.20	0.09	0.03	0.09	0.09	0.90	2.39	0.18	0.07	0.19	0.18	1.81
SILVER SHADOW	14.7	1.1	0.4	1.14	1.1	11.1	0.31	0.02	0.01	0.02	0.02	0.24	0.31	0.02	0.01	0.02	0.02	0.24
RHAPSODY OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	1.14	0.09	0.03	0.09	0.09	0.86	1.14	0.09	0.03	0.09	0.09	0.86
DIAMOND PRINCESS**	14.7	1.1	0.4	1.14	1.1	11.1	1.31	0.10	0.04	0.10	0.10	0.99	1.31	0.10	0.04	0.10	0.10	0.99
SUN PRINCESS**	14.7	1.1	0.4	1.14	1.1	11.1	1.31	0.10	0.04	0.10	0.10	0.99	1.31	0.10	0.04	0.10	0.10	0.99
AMSTERDAM	14.7	1.1	0.4	1.14	1.1	11.1	1.20	0.09	0.03	0.09	0.09	0.90	1.20	0.09	0.03	0.09	0.09	0.90
NORWEGIAN SUN	14.7	1.1	0.4	1.14	1.1	11.1	0.57	0.04	0.02	0.04	0.04	0.43	0.57	0.04	0.02	0.04	0.04	0.43
ZUIDERDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.28	0.02	0.01	0.02	0.02	0.22	0.28	0.02	0.01	0.02	0.02	0.22
												TOTAL:	**259.32**	**19.40**	**7.06**	**20.11**	**19.40**	**195.81**

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
Dole Costa Rica	14.7	1.1	0.4	1.14	1.1	11.1	2.57	0.19	0.07	0.20	0.19	1.94	43.76	3.27	1.19	3.39	3.27	33.04
Dole Ecuador	14.7	1.1	0.4	1.14	1.1	11.1	2.57	0.19	0.07	0.20	0.19	1.94	43.76	3.27	1.19	3.39	3.27	33.04
Dole Honduras	14.7	1.1	0.4	1.14	1.1	11.1	2.57	0.19	0.07	0.20	0.19	1.94	46.33	3.47	1.26	3.59	3.47	34.99
												TOTAL:	**133.85**	**10.02**	**3.64**	**10.38**	**10.02**	**101.07**

* Assumptions:
- Main Engines off during hoteling (except Diesel-Electric)
- All Engines are Cat. 3 burning RO
- Ave. Sulfur Content 2.7% RO
- Emission Factors US EPA Jan 06 Report

** Cruise Ships Capable of Shore Power

Prepared by:
Yorke ENGINEERING, LLC
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8/2/2007

Potential AIr Emissions Reduction with Marine Gasoline Oil

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
MONARCH OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	0.78	0.06	0.02	0.02	0.01	0.12	39.85	3.15	1.15	1.20	0.66	5.88
ELATION	13.9	1.1	0.4	0.42	0.23	2.05	0.86	0.07	0.02	0.03	0.01	0.13	41.38	3.27	1.19	1.25	0.68	6.10
OOSTERDAM**	13.9	1.1	0.4	0.42	0.23	2.05	0.97	0.08	0.03	0.03	0.02	0.14	28.13	2.23	0.81	0.85	0.47	4.15
CARNIVAL SPIRIT	13.9	1.1	0.4	0.42	0.23	2.05	1.02	0.08	0.03	0.03	0.02	0.15	24.57	1.94	0.71	0.74	0.41	3.62
RYNDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.46	0.04	0.01	0.01	0.01	0.07	7.79	0.62	0.22	0.24	0.13	1.15
ZAANDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.92	0.07	0.03	0.03	0.02	0.14	13.74	1.09	0.40	0.42	0.23	2.03
DAWN PRINCESS**	13.9	1.1	0.4	0.42	0.23	2.05	0.97	0.08	0.03	0.03	0.02	0.14	13.58	1.07	0.39	0.41	0.22	2.00
MERCURY	13.9	1.1	0.4	0.42	0.23	2.05	0.65	0.05	0.02	0.02	0.01	0.10	7.11	0.56	0.20	0.21	0.12	1.05
SUMMIT	13.9	1.1	0.4	0.42	0.23	2.05	0.86	0.07	0.02	0.03	0.01	0.13	4.31	0.34	0.12	0.13	0.07	0.64
SERENADE OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	1.24	0.10	0.04	0.04	0.02	0.18	3.72	0.29	0.11	0.11	0.06	0.55
GTS INFINITY	13.9	1.1	0.4	0.42	0.23	2.05	0.86	0.07	0.02	0.03	0.01	0.13	3.45	0.27	0.10	0.10	0.06	0.51
VOLENDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.92	0.07	0.03	0.03	0.02	0.14	2.75	0.22	0.08	0.08	0.05	0.41
CRYSTAL SYMPHONY	13.9	1.1	0.4	0.42	0.23	2.05	0.05	0.00	0.00	0.00	0.00	0.01	0.11	0.01	0.00	0.00	0.00	0.02
RADIANCE OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	0.92	0.07	0.03	0.03	0.02	0.14	1.83	0.14	0.05	0.06	0.03	0.27
SILVER SHADOW	13.9	1.1	0.4	0.42	0.23	2.05	0.24	0.02	0.01	0.01	0.00	0.04	0.24	0.02	0.01	0.01	0.00	0.04
RHAPSODY OF THE SEAS	13.9	1.1	0.4	0.42	0.23	2.05	0.86	0.07	0.02	0.03	0.01	0.13	0.86	0.07	0.02	0.03	0.01	0.13
DIAMOND PRINCESS**	13.9	1.1	0.4	0.42	0.23	2.05	1.02	0.08	0.03	0.03	0.02	0.15	1.02	0.08	0.03	0.03	0.02	0.15
SUN PRINCESS**	13.9	1.1	0.4	0.42	0.23	2.05	1.02	0.08	0.03	0.03	0.02	0.15	1.02	0.08	0.03	0.03	0.02	0.15
AMSTERDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.92	0.07	0.03	0.03	0.02	0.14	0.92	0.07	0.03	0.03	0.02	0.14
NORWEGIAN SUN	13.9	1.1	0.4	0.42	0.23	2.05	0.43	0.03	0.01	0.01	0.01	0.06	0.43	0.03	0.01	0.01	0.01	0.06
ZUIDERDAM	13.9	1.1	0.4	0.42	0.23	2.05	0.22	0.02	0.01	0.01	0.00	0.03	0.22	0.02	0.01	0.01	0.00	0.03
												TOTAL:	**197.03**	**15.59**	**5.67**	**5.95**	**3.26**	**29.06**

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
Dole Costa Rica	13.9	1.1	0.4	0.42	0.23	2.05	2.36	0.19	0.07	0.07	0.04	0.35	40.05	3.17	1.15	1.21	0.66	5.91
Dole Ecuador	13.9	1.1	0.4	0.42	0.23	2.05	2.36	0.19	0.07	0.07	0.04	0.35	40.05	3.17	1.15	1.21	0.66	5.91
Dole Honduras	13.9	1.1	0.4	0.42	0.23	2.05	2.36	0.19	0.07	0.07	0.04	0.35	42.41	3.36	1.22	1.28	0.70	6.25
												TOTAL:	**122.51**	**9.69**	**3.53**	**3.70**	**2.03**	**18.07**

* Assumptions:
- Main Engines off during hoteling (except Diesel-Electric)
- All Engines are Cat. 3 burning MGO
- Ave. Sulfur Content 0.5%
- Emission Factors US EPA Jan 06 Report

** Cruise Ships Capable of Shore Power

Prepared by:
Yorke ENGINEERING, LLC
www.YorkeEngr.com

8/2/2007

Potential Air Emissions Reduction with Residual Oil

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
MONARCH OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	0.83	0.06	0.02	0.06	0.06	0.62	42.14	3.15	1.15	3.27	3.15	31.82
ELATION	14.7	1.1	0.4	1.14	1.1	11.1	0.91	0.07	0.02	0.07	0.07	0.69	43.77	3.27	1.19	3.39	3.27	33.05
OOSTERDAM**	14.7	1.1	0.4	1.14	1.1	11.1	1.03	0.08	0.03	0.08	0.08	0.77	29.75	2.23	0.81	2.31	2.23	22.46
CARNIVAL SPIRIT	14.7	1.1	0.4	1.14	1.1	11.1	1.08	0.08	0.03	0.08	0.08	0.82	25.99	1.94	0.71	2.02	1.94	19.62
RYNDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.48	0.04	0.01	0.04	0.04	0.37	8.23	0.62	0.22	0.64	0.62	6.22
ZAANDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.97	0.07	0.03	0.08	0.07	0.73	14.53	1.09	0.40	1.13	1.09	10.97
DAWN PRINCESS**	14.7	1.1	0.4	1.14	1.1	11.1	1.03	0.08	0.03	0.08	0.08	0.77	14.36	1.07	0.39	1.11	1.07	10.84
MERCURY	14.7	1.1	0.4	1.14	1.1	11.1	0.68	0.05	0.02	0.05	0.05	0.52	7.52	0.56	0.20	0.58	0.56	5.68
SUMMIT	14.7	1.1	0.4	1.14	1.1	11.1	0.91	0.07	0.02	0.07	0.07	0.69	4.56	0.34	0.12	0.35	0.34	3.44
SERENADE OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	1.31	0.10	0.04	0.10	0.10	0.99	3.93	0.29	0.11	0.30	0.29	2.97
GTS INFINITY	14.7	1.1	0.4	1.14	1.1	11.1	0.91	0.07	0.02	0.07	0.07	0.69	3.65	0.27	0.10	0.28	0.27	2.75
VOLENDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.97	0.07	0.03	0.08	0.07	0.73	2.91	0.22	0.08	0.23	0.22	2.19
CRYSTAL SYMPHONY	14.7	1.1	0.4	1.14	1.1	11.1	0.06	0.00	0.00	0.00	0.00	0.04	0.11	0.01	0.00	0.01	0.01	0.09
RADIANCE OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	0.97	0.07	0.03	0.08	0.07	0.73	1.94	0.14	0.05	0.15	0.14	1.46
SILVER SHADOW	14.7	1.1	0.4	1.14	1.1	11.1	0.26	0.02	0.01	0.02	0.02	0.19	0.26	0.02	0.01	0.02	0.02	0.19
RHAPSODY OF THE SEAS	14.7	1.1	0.4	1.14	1.1	11.1	0.91	0.07	0.02	0.07	0.07	0.69	0.91	0.07	0.02	0.07	0.07	0.69
DIAMOND PRINCESS**	14.7	1.1	0.4	1.14	1.1	11.1	1.08	0.08	0.03	0.08	0.08	0.82	1.08	0.08	0.03	0.08	0.08	0.82
SUN PRINCESS**	14.7	1.1	0.4	1.14	1.1	11.1	1.08	0.08	0.03	0.08	0.08	0.82	1.08	0.08	0.03	0.08	0.08	0.82
AMSTERDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.97	0.07	0.03	0.08	0.07	0.73	0.97	0.07	0.03	0.08	0.07	0.73
NORWEGIAN SUN	14.7	1.1	0.4	1.14	1.1	11.1	0.46	0.03	0.01	0.04	0.03	0.34	0.46	0.03	0.01	0.04	0.03	0.34
ZUIDERDAM	14.7	1.1	0.4	1.14	1.1	11.1	0.23	0.02	0.01	0.02	0.02	0.17	0.23	0.02	0.01	0.02	0.02	0.17
												TOTAL:	**208.37**	**15.59**	**5.67**	**16.16**	**15.59**	**157.34**

Vessel	Emission Factors * (g/kw-hr)						Emissions per Call (tons)						Emissions per Year (tons)					
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_X
Dole Costa Rica	14.7	1.1	0.4	1.14	1.1	11.1	2.49	0.19	0.07	0.19	0.19	1.88	42.36	3.17	1.15	3.28	3.17	31.98
Dole Ecuador	14.7	1.1	0.4	1.14	1.1	11.1	2.49	0.19	0.07	0.19	0.19	1.88	42.36	3.17	1.15	3.28	3.17	31.98
Dole Honduras	14.7	1.1	0.4	1.14	1.1	11.1	2.49	0.19	0.07	0.19	0.19	1.88	44.85	3.36	1.22	3.48	3.36	33.86
												TOTAL:	**129.56**	**9.69**	**3.53**	**10.05**	**9.69**	**97.83**

* Assumptions:
- Main Engines off during hoteling (except Diesel-Electric)
- All Engines are Cat. 3 burning RO
- Ave. Sulfur Content 2.7% RO
- Emission Factors US EPA Jan 06 Report

** Cruise Ships Capable of Shore Power

Prepared by:

Yorke ENGINEERING, LLC
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Equivalent Emissions from Power Generation

Total Power Consumed by Shore Power Capable Cruise Ships per Year 2,858,240 kW

Total Power Consumed by Dole Ship per Year 8,002,758 kW

	Emission Factors * (lb/kW-h)						Emissions per Call (tons)						Emissions per Year (tons)				
	NO_X	CO	VOC	PM	CO_2	SO_X	NO_X	CO	VOC	PM	CO_2	SO_X	NO_X	CO	VOC	PM	CO_2
OOSTERDAM**	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.00	0.01	0.00	0.00	6.38	0.00	0.12	0.16	0.10	0.02	185.11
DAWN PRINCESS**	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.00	0.01	0.00	0.00	6.38	0.00	0.06	0.08	0.05	0.01	89.36
DIAMOND PRINCESS**	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.00	0.01	0.00	0.00	6.74	0.00	0.00	0.01	0.00	0.00	6.74
SUN PRINCESS**	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.00	0.01	0.00	0.00	6.74	0.00	0.00	0.01	0.00	0.00	6.74
						TOTAL	**0.017**	**0.022**	**0.014**	**0.003**	**26.242**	**0.003**	**0.186**	**0.243**	**0.157**	**0.029**	**287.953**
Dole Vessels																	
Dole Costa Rica	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.01	0.01	0.01	0.00	15.50	0.00	0.17	0.22	0.14	0.03	263.58
Dole Ecuador	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.01	0.01	0.01	0.00	15.50	0.00	0.17	0.22	0.14	0.03	263.58
Dole Honduras	0.00013	0.00017	0.00011	0.00002	0.20149	0.00002	0.01	0.01	0.01	0.00	15.50	0.00	0.18	0.24	0.15	0.03	279.08
						TOTAL	**0.03**	**0.04**	**0.03**	**0.00**	**46.51**	**0.00**	**0.52**	**0.68**	**0.44**	**0.08**	**806.24**
						TOTAL: (Dole + Cruise Ships)	**0.05**	**0.06**	**0.04**	**0.01**	**72.76**	**0.01**	**0.71**	**0.92**	**0.60**	**0.11**	**1094.19**

Note: Emissions factors obtained from Table 6 of *Air Pollution Emission Impacts Associated with Economic Market Potential of Distributed Generation in California* prepared for the CARB and EPA

Prepared by:

Yorke ENGINEERING, LLC
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Summary Sheet for 2007 Data with MGO

CRUISE SHIPS - ALL SHIPS	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Totals Air Emissions	245.21	19.40	7.06	7.41	4.06	36.16
Total Emissions Available for Shore Power (minus hookup time)	197.03	15.59	5.67	5.95	3.26	29.06
% Emissions Reduction Potential	**80.4%**	**80.4%**	**80.4%**	**80.4%**	**80.4%**	**80.4%**

CRUISE SHIPS - CURRENTLY SHORE POWER CAPABLE	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Totals Air Emissions	53.45	4.23	1.54	1.62	0.88	7.88
Total Emissions Available for Shore Power (minus hookup time)	43.75	3.46	1.26	1.32	0.72	6.45
% Emissions Reduction Potential	**81.9%**	**81.9%**	**81.9%**	**81.9%**	**81.9%**	**81.9%**

% Reduction of Total for Shore Power Ships	**17.8%**	**17.8%**	**17.8%**	**17.8%**	**17.8%**	**17.8%**

DOLE VESSELS	NO_X (tpy)	CO (tpy)	HC (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_X (tpy)
Totals Air Emissions	126.57	10.02	3.64	3.82	2.09	18.67
Total Emissions Available for Shore Power (minus hookup time)	122.51	9.69	3.53	3.70	2.03	18.07
% Emissions Reduction Potential	**96.8%**	**96.8%**	**96.8%**	**96.8%**	**96.8%**	**96.8%**

POWER PLANT EMISSIONS FOR TOTAL SHORE POWER DEMAND	NO_X (tpy)	CO (tpy)	HC (tpy)	PM (tpy)	SO_X (tpy)
Total Emissions for Power Plant	**0.71**	**0.92**	**0.60**	**0.11**	**0.11**

Note: Power power emissions are mininal compare to emissions from cruise ships and Dole ships.

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APPENDIX D – SHORE POWER INSTALLTION CAPITAL COST ESTIMATE

Cruise Ship- Pier B

Shore Power Terminal/ Pier Installation Costs*

	First Ship	Second Ship
Electrical Design & Engineering	$ 60,000.00	$ 60,000.00
Utility Engineering and Connection Fees	$ 75,000.00	$ 75,000.00
Electrical Gear and Equipment	$ 750,000.00	$ 750,000.00
Transformer	$ 350,000.00	$ 350,000.00
Infrastructure (Duct bank and cables)	$ 120,000.00	$ 120,000.00
Ship Cables and Connectors	$ 250,000.00	$ 250,000.00
Cable Management (Jib/Chain Winch)	$ 10,000.00	$ 10,000.00
Electrical Permit	$ 15,000.00	$ 15,000.00
	$ 1,630,000.00	$ 1,630,000.00
Inflation and local adjustment 25%	$ 407,500.00	$ 407,500.00
	Total	**$ 4,075,000.00**

* Actual Costs Totaling 1.63m Provided by Cochran, Inflation & Local Adjustment by Yorke Engineering, LLC
** Full Capability for Two Ships Simultaneously on Opposite Sides of Pier B.

Dole Reefers- 10th Ave. Terminal

Shore Power Terminal/ Pier Installation Costs*

	*One Side of Dock	**Second Side (only power to one ship at a time)
Electrical Design & Engineering	$ 60,000.00	n/a
Utility Engineering and Connection Fees	$ 75,000.00	n/a
Electrical Gear and Equipment	$ 750,000.00	n/a
Transformer	$ 350,000.00	n/a
Infrastructure (Duct bank and cables)	$ 120,000.00	n/a
Ship Cables and Connectors	$ 250,000.00	n/a
Cable Management (Jib/Chain Winch)	$ 10,000.00	n/a
Electrical Permit	$ 15,000.00	n/a
	$ 1,630,000.00	-
	Total	**$ 1,630,000.00**
Inflation and local adjustment 25%		$ 407,500.00
	Estimated Installation Costs	**$ 2,037,500.00**

* Actual Costs Totaling 1.63m Provided by Cochran
** Dole runs sister ships into San Diego and would have the same location for power cables

APPENDIX E – MARINE EXCHANGE DATABASE – DOLE VESSELS

2006 DOLE Berthing Data

ref#	Vessel	Arrival	Arrival Day Berthing Duration	Complete Days	Departing Day Berthing Duration	Total Duration (hrs)	Departure	next port	Berthing Locations
07-0147	Dole Costa Rica	08-26-06 at 17:45	6:15:00	48:00:00	19:00	73:15:00	08-29-06 at 19:00	Caldera, Costa Rica	Berth 10-02
07-0200	Dole Costa Rica	09-16-06 at 20:45	3:15:00	48:00:00	18:38	69:53:00	09-19-06 at 18:38	Caldera, Costa Rica	Berth 10-02
07-0341	Dole Costa Rica	10-29-06 at 20:15	3:45:00	24:00:00	16:15	44:00:00	10-31-06 at 16:15	Caldera, Costa Rica	Berth 10-02
07-0418	Dole Costa Rica	11-18-06 at 20:21	3:39:00	24:00:00	19:10	46:49:00	11-21-06 at 19:10	Caldera, Costa Rica	Berth 10-02
07-0267	Dole Costa Rica	10-07-06 at 21:50	2:10:00	48:00:00	20:15	70:25:00	10-10-06 at 20:15	Caldera, Costa Rica	Berth 10-02
					Ave. Costa Rica	**60:52:24**			
06-0613	Dole Ecuador	01-14-06 at 21:25	2:35:00	48:00:00	19:38	70:13:00	01-17-06 at 19:38	Caldera, Costa Rica	Berth 10-02
06-0675	Dole Ecuador	02-05-06 at 10:00	14:00:00	24:00:00	18:53	56:53:00	02-07-06 at 18:53	Caldera, Costa Rica	Berth 10-02
06-0736	Dole Ecuador	02-26-06 at 15:05	8:55:00	24:00:00	19:55	52:50:00	02-28-06 at 19:55	Caldera, Costa Rica	Berth 10-02
06-0806	Dole Ecuador	03-19-06 at 10:26	13:34:00	24:00:00	18:26	56:00:00	03-21-06 at 18:26	Caldera, Costa Rica	Berth 10-02
06-0940	Dole Ecuador	04-30-06 at 09:30	14:30:00	48:00:00	0:36	63:06:00	05-03-06 at 00:36	Caldera, Costa Rica	Berth 10-02
07-0016	Dole Ecuador	07-02-06 at 06:10	17:50:00	24:00:00	18:45	60:35:00	07-04-06 at 18:45	Caldera, Costa Rica	Berth 10-02
07-0431	Dole Ecuador	11-25-06 at 06:25	17:35:00	48:00:00	18:14	83:49:00	11-28-06 at 18:14	Caldera, Costa Rica	Berth 10-02
07-0374	Dole Ecuador	11-05-06 at 07:28	16:32:00	24:00:00	18:40	59:12:00	11-07-06 at 18:40	Caldera, Costa Rica	Berth 10-02
07-0284	Dole Ecuador	10-15-06 at 07:56	16:04:00	24:00:00	18:04	58:08:00	10-17-06 at 18:04	Caldera, Costa Rica	Berth 10-02
07-0218	Dole Ecuador	09-24-06 at 06:52	17:08:00	24:00:00	18:36	59:44:00	09-26-06 at 18:36	Caldera, Costa Rica	Berth 10-02
07-0120	Dole Ecuador	08-13-06 at 08:40	15:20:00	24:00:00	19:08	58:28:00	08-15-06 at 19:08	Caldera, Costa Rica	Berth 10-02
07-0061	Dole Ecuador	07-22-06 at 21:30	2:30:00	24:00:00	18:35	45:05:00	07-25-06 at 18:35	Caldera, Costa Rica	Berth 10-02
06-1057	Dole Ecuador	06-11-06 at 11:22	12:38:00	24:00:00	17:55	54:33:00	06-13-06 at 17:55	Caldera, Costa Rica	Berth 10-02
06-1007	Dole Ecuador	05-21-06 at 11:25	12:35:00	24:00:00	19:54	56:29:00	05-23-06 at 19:54	Caldera, Costa Rica	Berth 10-02
06-0878	Dole Ecuador	04-09-06 at 09:38	14:22:00	24:00:00	23:05	61:27:00	04-11-06 at 23:05	Caldera, Costa Rica	Berth 10-02
					Ave. Ecuador	**59:46:08**			
06-0823	Dole Honduras	03-26-06 at 06:05	17:55:00	24:00:00	18:25	60:20:00	03-28-06 at 18:25	Caldera, Costa Rica	Berth 10-02
07-0396	Dole Honduras	11-11-06 at 20:35	3:25:00	48:00:00	18:48	70:13:00	11-14-06 at 18:48	Caldera, Costa Rica	Berth 10-02
07-0188	Dole Honduras	09-09-06 at 17:05	6:55:00	72:00:00	16:15	95:10:00	09-13-06 at 16:15	Caldera, Costa Rica	Berth 10-02
07-0132	Dole Honduras	08-19-06 at 21:32	2:28:00	48:00:00	20:06	70:34:00	08-22-06 at 20:06	Caldera, Costa Rica	Berth 10-02
07-0074	Dole Honduras	07-29-06 at 16:32	7:28:00	48:00:00	22:40	78:08:00	08-01-06 at 22:40	Caldera, Costa Rica	Berth 10-02
07-0029	Dole Honduras	07-09-06 at 06:45	17:15:00	24:00:00	19:50	61:05:00	07-11-06 at 19:50	Caldera, Costa Rica	Berth 10-02
06-1071	Dole Honduras	06-18-06 at 07:51	16:09:00	24:00:00	19:05	59:14:00	06-20-06 at 19:05	Caldera, Costa Rica	Berth 10-02
06-1019	Dole Honduras	05-27-06 at 19:23	4:37:00	48:00:00	18:31	71:08:00	05-30-06 at 18:31	Caldera, Costa Rica	Berth 10-01
06-0966	Dole Honduras	05-07-06 at 18:45	5:15:00	24:00:00	19:08	48:23:00	05-09-06 at 19:08	Caldera, Costa Rica	Berth 10-02
06-0895	Dole Honduras	04-16-06 at 06:55	17:05:00	24:00:00	20:18	61:23:00	04-18-06 at 20:18	Caldera, Costa Rica	Berth 10-01
06-0760	Dole Honduras	03-05-06 at 06:25	17:35:00	24:00:00	19:21	60:56:00	03-07-06 at 19:21	Caldera, Costa Rica	Berth 10-02
06-0699	Dole Honduras	02-12-06 at 14:20	9:40:00	48:00:00	11:55	69:35:00	02-15-06 at 11:55	Caldera, Costa Rica	Berth 10-02
06-0626	Dole Honduras	01-21-06 at 20:36	3:24:00	24:00:00	20:05	47:29:00	01-23-06 at 20:05	Caldera, Costa Rica	Berth 10-02
06-0563	Dole Honduras	01-01-06 at 08:38	15:22:00	48:00:00	4:05	67:27:00	01-04-06 at 04:05	Caldera, Costa Rica	Berth 10-02
					Ave. Honduras	**65:47:30**			
					Average Stay for all visits	**62:24:41**	**or 62.4 Hrs**		

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