

**CARB Staff Analysis of Potential Emission Reduction Strategies by Port/Terminal/Berth**  
**For Crude and Product Tanker Vessels**  
**May 2019**

The berth analysis is an assessment made by California Air Resources Board (CARB) staff to characterize what additional shore power infrastructure improvements and potential emission control technologies (land- or barge-based alternative capture and control systems) may be necessary to support the new draft At Berth Regulation for tanker vessels. For the development of the analysis CARB staff relied on port maps, Google Earth maps, and vessel visit information from Wharfinger, San Francisco Marine Exchange, and California State Lands Commission data. CARB staff's assessment was based on comment letters received from industry stakeholders in response to the new draft At Berth Regulation, numerous port/terminal site visits and tours, extensive discussions with terminal operators, Port staff throughout the state, and harbor pilots servicing the Northern and Southern California Ports.

The assessment is also intended to assist CARB staff to estimate the potential cost impacts that could be incurred due to infrastructure and/or equipment upgrades as a result of the requirements of the new draft At Berth Regulation.

If you have any comments, feedback and/or updated information we would welcome additional information to further refine this analysis. Please submit your feedback to CARB via email to Nicole Light ([nicole.light@arb.ca.gov](mailto:nicole.light@arb.ca.gov)) or Lynsay Carmichael ([lynsay.carmichael@arb.ca.gov](mailto:lynsay.carmichael@arb.ca.gov)).

**Legend:**

C+C= capture and control system

SP= shore power

Spud barge= is a type of barge that is moored by using through-deck pilings or steel shafts

**Subject Headers:**

- **# of Tanker Visits in 2017** = Total number of tanker vessel visits by berth based on 2017 visit information

- **# of Frequent Tanker Vessels Visiting Terminals in 2017** = Number of frequent (vessel that visits the same berth in California at least 4 times in a year) tanker vessels by port/marine terminal complex

- **# of Visits by Frequent Tanker Vessels in 2017** = Number of visits made by frequent tanker vessels by port/marine terminal complex

- **Assumed Control Technology & Estimated # of C+C Systems Needed** = Type of emissions control technology that CARB staff's analysis indicates may be most feasible for use and estimated number of emission capture and control system (land- or barge-based) that CARB staff estimates will be necessary per port/marine terminal complex

- **Additional Infrastructure Improvements Needed?** = Additional landside infrastructure improvements needed to support the emission control technology assumption for a given port/marine terminal complex (in some situations infrastructure upgrades, such as wharf improvements may be necessary to support a land-based emission control strategy)

- **Reasoning** = Basis for CARB staff analysis and assumptions

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Port/Terminal/Berth	# of Tanker Visits in 2017	# of Frequent Tanker Vessels Visiting Terminals in 2017	# of Visits by Frequent Tanker Vessels in 2017	Assumed Control Technology & Estimated # of C+C Systems Needed	Additional Infrastructure Improvements Needed?	Reasoning
<b>Carquinez</b>	<b>241</b>	<b>7</b>	<b>58</b>	<b>5 Land-based C+C, 6 cranes</b>	<b>Yes</b>	
Pacific Atlantic	41	3	24	1 Land-based C+C, 1 crane	Yes	
Berth MRZ 6	41	3	24	1 crane	Yes	Per SF Bar pilots, a barge-based C+C system would present navigational concerns at this location due to interaction with vessels passing close by under the nearby UPRR bridge. CARB staff analysis of satellite imagery indicates there may be available space for an land-based C+C system in the facility's parking lot. If unable to place system on land, wharf improvements may be necessary to support the weight of a C+C system and piping. Adapting a land-based C+C system and crane will have to account for the wetlands surrounding the pipelines on all sides as it extends from the berth to the treatment facility further inland.
Shell	53	0	0	1 Land-based C+C, 2 cranes	Yes	
Berth MRZ 2	23	0	0	1 crane	Yes	Although SF Bar Pilots did not have any significant navigational concerns about using a barge-based C+C system at these berths, Shell terminal staff have voiced concerns about using the barge due to mooring line interference. Staff assumes that the berths will likely require structural wharf reinforcements to be able to accommodate piping for transferring exhaust gas. CARB staff saw during a field visit to this terminal that a thermal oxidizer facility used for treating VOC emissions is located onshore (off the berth) and assumes a land-based emissions treatment facility could potentially be located near this thermal oxidizer, and that onshore pipings connecting to each capture bonnet can be both routed to the same treatment destination.
Berth MRZ 3	30	0	0	1 crane	Yes	

One berth used 128 days of the year, two berths used at same time 15 days of the year (in 2017)

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Tesoro - Avon	53	1	4	1 Land-based C+C, 1 crane	Yes	
Berth MRZ 5	53	1	4	1 crane	Yes	Per SF Bar pilots, a barge-based C+C system would present navigational concerns at this location due to interaction with vessels passing close by under the nearby UPRR bridge. CARB staff analysis indicates a potential need for berth reinforcement if a land-based C+C system is used, in order to run additional piping onshore. CARB staff analysis also indicates there may be room for the emissions treatment facility on the western side of the facility.
Tesoro - Amorcio	41	2	11	1 Land-based C+C, 1 crane	Yes	
Berth MRZ 8	41	2	11	1 crane	Yes	Per SF Bar pilots, a barge-based C+C system would present navigational concerns at this location due to the proximity to the Federal Channel. CARB staff analysis of satellite imagery indicates a potential need for berth reinforcement if a land-based C+C system is used, in order to run additional piping onshore. CARB staff analysis also indicates possible space for the emissions treatment facility to be located on a concrete inland wharf at the edge of a lagoon near the berth; pipelines at this berth cross over a long stretch of wetlands, similar to MRZ 6.
Valero	53	1	19	1 Land-based C+C, 1 crane	Yes	
Berth BNC 4	53	1	19	1 crane	Yes	SF Bar Pilots did not have any significant navigational concerns about using a barge-based C+C system at this BNC 4 given the distance from the Federal Channel. However, terminal staff have raised express concerns on the water current flow patterns and speeds around the berth and the affects of the current on a vessel tied to this berth. CARB staff analysis of satellite imagery indicates a potential need for berth reinforcement if a land-based C+C system is used to accomodate the additional piping. The piping lines are routed over a set of adjacent railway tracks running paraleel to the shore, the exhaust piping will have to travel the same path. CARB staff analysis also indicates possible locations for the onshore emissions treatment facility may be the parking lot adjacent to the Carquinez bridge.

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Long Beach	368	16	115	5 Land-based C+C, 8 cranes	Yes	CARB staff assuming land-based C+C due to safety concerns about barge tying up to a tanker vessel. Jacobson Pilots expressed navigation concern about using a barge-based C+C at Tesoro - Pier B and Tesoro - Pier T; no navigational concerns expressed by harbor pilots at Chemoil or Vopak.
Chemoil	43	1	7	1 Land-based C+C, 1 crane	Yes	Jacobson Pilots advised there is room for a barge-based system navigationally at this location, however, CARB staff assuming land-based C+C due to industry preference considering safety concerns about barge tying up to a tanker vessel.
Berth F209	43	1	7	1 crane	Yes	Jacobson Pilots advised there is room for a barge-based system navigationally at this location, however, CARB staff assuming land-based C+C due to industry preference considering safety concerns about barge tying up to a tanker vessel.
Tesoro - Pier B	155	6	44	2 Land-based C+C, 5 cranes	Yes	Jacobson Pilots at POLB stated using a barge-based C+C system at any berth at Pier B would block navigational access to the channel. Per POLA staff, Pier B is not one a contiguous reinforced structure. Two land-based C+C would likely be needed to cover all berths, as they are not in the same physical location (one at berths B77-B78, one at Berths B84-B86)
Berth B77	14	1	4	1 crane	Yes	Jacobson Pilots at POLB stated using a barge-based C+C system at any berth at Pier B would block navigational access to the channel. Per POLA staff, Pier B is not one a contiguous reinforced structure. Two land-based C+C would likely be needed to cover all berths, as they are not in the same physical location (one at berths B77-B78, one at Berths B84-B86)
Berth B78	46	3	16	1 crane	Yes	
Berth B84	10	0	0	1 crane	Yes	
Berth B84A	54	1	18	1 crane	Yes	
Berth B86	31	1	6	1 crane	Yes	
One berth used 185 days of the year, two berths used at same time 97 days of the year, three berths used at same time 20 days of the year (in 2017)						

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Tesoro - Pier T	161	9	64	1 Land-based C+C, 1 crane	Yes	
Berth T121	161	9	64	1 crane	Yes	Berth already has SP, but likely to need a C+C system for majority of visits from non-SP capable vessels, as industry has expressed a lack of desire for installing SP connections on tanker vessels. Jacobson Pilots stated using a barge-based C+C system at Pier T would block navigational access to the channel. Therefore, staff assumed a land-based C+C system and a crane would be best suited for this terminal.
Vopak Long Beach	9	0	0	1 Land-based C+C, 1 crane	Yes	
Berth S101	9	0	0	1 crane	Yes	Jacobson Pilots advised there is room for a barge-based system navigational at this location, however, CARB staff assuming land-based C+C and crane due to industry preference considering safety concerns about barge tying up to a tanker vessel.

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Los Angeles	209	5	28	5 Land-based C+C, 6 cranes	Yes	CARB staff assuming land-based C+C due to safety concerns about barge tying up to a tanker vessel. LA Pilots expressed navigation concern about using a barge-based C+C at PBF Energy and Phillips 66 terminals; no navigational concerns at Shell, Valero, or Vopak.
Kinder Morgan	22	2	10	N/A	N/A	N/A - Berth will be demolished
Berth 118 (To Be Demolished)	22	2	10	N/A	N/A	POLA staff advised that the entire length of three berths (118 through 120) will be demolished and no longer serve as tanker berth after the next 5 years (2024).
PBF Energy	20	2	14	1 Land-based C+C, 1 crane	N/A	
Berth 238 (To Be Upgraded)	20	2	14	1 crane	N/A	Per LA Pilots, there are wave interaction concerns with using a barge-based C+C system at this berth. Staff assumed a land-based C+C system and crane would be best suited for the terminal.
Phillips 66	32	1	4	1 Land-based C+C, 1 crane	lo (already upgrading)	
Berth 149 (To Be Demolished)	32	1	4	N/A	N/A	Per LA Pilots, there are wave interaction concerns with using a barge-based C+C system at this berth. Staff assumed a land-based C+C system and crane would be best suited for the terminal. POLA staff advised that berth 149 will be left in place as a non-oil vessel i.e. barge servicing reinforced berth and construction of a new oil terminal is proposed for Berth 151 after demolition of the existing 150-151 berth.
Berth 151 (To Be Upgraded)	Assume similar visit count as Berth 149 after it is demolished	---	---	1 crane	No (already upgrading)	

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Shell	38	0	0	1 Land-based C+C, 1 crane	No (already upgrading)	
Berth 168	1	0	0	N/A	N/A	LA Pilots advised there is room for a barge-based system navigationally at this location, however, CARB staff assuming land-based C+C and crane due to industry preference considering safety concerns about barge tying up to a tanker vessel. Per POLA staff, Berth 168 will be demolished and replaced with a new MOTEMS-compliant terminal while the tenant operates at the existing Berth 169. Once Berth 169 is finished and operational, the tenant will move all of their operations to Berth 168 and berth 169 will be demolished.
Berth 169	37	0	0	1 crane	No (already upgrading)	
One berth used 155 days of the year, two berths used at same time 2 days of the year (in 2017)						
Valero	24	0	0	1 Land-based C+C, 1 crane	No (already upgrading)	
Berth 164	24	0	0	1 crane	No (already upgrading)	LA Pilots advised there is room for a barge-based system navigationally at this location, however, CARB staff assuming land-based C+C and crane due to industry preference considering safety concerns about barge tying up to a tanker vessel. Per POLA staff the berth will be replaced with a MOTEMS compliant structure.
Vopak	73	0	0	1 Land-based C+C, 2 cranes	Yes	
Berth 187	18	0	0	1 crane	Yes	LA Pilots advised there is room for a barge-based system navigationally at this berth, however, CARB staff assuming land-based C+C and cranes
Berth 189	55	0	0	1 crane	Yes	
One berth used 215 days of the year, two berths used at same time 30 days of the year (in 2017)						



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<b>Richmond</b>	<b>403</b>	<b>15</b>	<b>215</b>	<b>5 Land-based C+C, 12 cranes</b>	<b>Yes</b>	
BP/ARCO	40	2	39	1 Land-based C+C, 1 crane	Yes	
Berth RCH 9	40	2	39	1 crane	Yes	SF Bar Pilots did not have any significant navigational concerns about using a barge-based C+C system at this berth location, however CARB staff assuming land-based C+C due to terminal's concerns about barge tying up to a tanker vessel at this berth. Staff assumed a land-based C+C and crane is employed, and that the berth would probably have to be structurally reinforced. CARB staff's analysis of satellite imagery shows the parking lot south of the main building structure adjacent to the berth may be a suitable location for an onshore emissions treatment facility.
<b>Chevron - Richmond Long Wharf</b>	<b>283</b>	<b>12</b>	<b>160</b>	<b>1 Land-based C+C, 8 cranes</b>	<b>Yes</b>	
Berth RLW 1	45	1	7	2 cranes	Yes	SF Bar Pilots did not have any significant navigational concerns about using a barge-based C+C system at this berth location, however, Chevron-specific docking pilots did express concern about weather and wave interaction from passing vessels, increasing vessel traffic congestion if barges are used, and the ability to disembark the vessel within 30 minutes. For this analysis, CARB staff are assuming land-based C+C due to the docking pilot's and terminal's concerns about barge tying up to a tanker vessel at this berth. Staff made the assumption that two cranes would be needed per berth rather than one, based on a comment letter from Chevron (dated March 8, 2019) advising staff that two cranes may be needed at each berth at the long wharf to provide flexibility when vessels dock.
Berth RLW 2	67	2	18	2 cranes	Yes	
Berth RLW 3	38	2	18	2 cranes	Yes	
Berth RLW 4	133	7	117	2 cranes	Yes	
One berth used 111 days of the year, two berths used at same time 147 days of the year, three berths used at same time 74 days of the year, four berths used at same time 15 days of the year (in 2017)						

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Phillips 66/Kinder Morgan	38	0	0	1 Land-based C+C, 1 crane	Yes	
Berth RCH 11	38	0	0	1 crane	Yes	SF Bar Pilots did not indicate any significant navigational concerns about using a barge-based C+C system at this berth. Terminal staff raised concerns about RCH 11 using the barge strategy, since one of the berths is dedicated as a berthing spot for barges while the other berth is for ocean-going tanker vessels. CARB staff analysis of satellite imagery indicates that if a land-based C+C system is used, the available room to place the onshore emissions treatment facility may either be the space between the berth and the tank farm or west past the tank farm, and that the berth itself may need to be reinforced to accommodate for the additional piping.
IMTT	12	0	0	1 Land-based C+C, 1 crane	Yes	
Berth RCH 17	12	0	0	1 crane	Yes	SF Bar Pilots indicated the channel that the berth faces is too narrow for barge-based C+C system. Basis CARB staff analysis of satellite imagery, the berth may have to be reinforced to be able to handle an additional piping in order to use a land-based C+C system, with the corner of the "triangular" empty space could potentially be a site for the onshore emissions treatment facility.
Pacific Atlantic	30	1	16	1 Land-based C+C, 1 crane	Yes	
Berth RCH 22	30	1	16	1 crane	Yes	SF Bar Pilots indicated the channel that the berth faces is too narrow for barge-based C+C system. Basis CARB staff analysis of satellite imagery, the berth may have to be reinforced to be able to handle the additional piping needed for a land-based C+C, and the parking lot behind the warehouse adjacent to the berth (or part of the warehouse itself) could potentially be used to site the onshore emissions treatment facility.

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<b>Rodeo</b>	<b>108</b>	<b>1</b>	<b>4</b>	<b>2 Land-based C+C, 3 cranes</b>	<b>Yes</b>	
Phillips 66 - Oleum	85	0	0	1 Land-based C+C, 2 cranes	Yes	
Berth ROD 3		0	0	1 crane	Yes	SF Bar Pilots have raised concerns that barge-based C+C systems would present a navigational risk for this terminal. CARB staff's analysis of satellite maps of the berth indicate there may be room on the berth to run additional pipings to the shore if a land-based C+C and cranes are used. CARB staff analysis also indicates potential shoreside space for the onshore emissions treatment facility may be available if it is situated west of the roadway connecting the shore to the berth.
	85					
Berth ROD 4		0	0	1 crane	Yes	
One berth used 108 days of the year, two berths used at same time 12 days of the year (in 2017)						
NuStar - Selby	23	1	4	1 Land-based C+C, 1 crane	Yes	
Berth ROD 8	23	1	4	3	Yes	SF Bar Pilots indicated barge-based C+C systems would present a navigational risk for this terminal. CARB staff's analysis of satellite maps of the onshore infrastructure for ROD 8 indicates there is sufficient space for an onshore emissions treatment facility. CARB staff analysis also indicates that the berth may need reinforcing in order to accommodate the additional piping and crane.

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<b>Stockton</b>	<b>55</b>	<b>1</b>	<b>7</b>	<b>1 Land-based C+C, 3 cranes</b>	<b>No</b>	<b>CARB staff is still in the process of the Port evaluation.</b>
Stockton Port Authority	55	1	7	1 Land-based C+C, 3 cranes	No	
Berth SCK 2-3	13	0	0	1 crane	No	SF Bar Pilots did not indicate any significant navigational concerns about using a barge-based C+C at this berth.
Berth SCK 7-8	34	1	7	1 crane		SF Bar Pilots expressed concern using a barge-based system at Berths 8-9 due to navigational constraints in the channel. Based on satellite
Berth SCK 9	8	0	0	1 crane		
One berth used 131 days of the year, two berths used at same time 23 days of the year, three berths used at same time 2 days of the year (in 2017)						

Port/Terminal/Berth	# of Tanker Visits in 2017	Assumed Control Technology & Estimated # of C+C Systems Needed
<b>Statewide #'s</b>	<b>1384</b>	<b>23 Land-based C+C, 38 cranes</b>

\*CARB staff made the assumption that all tanker terminals will use a land-based capture and control (C+C system) due to safety concerns industry has expressed with having a barge-based C+C tied up  
 \*\*CARB staff made assumption that all tanker terminals using a land-based C+C will use a centralized exhaust gas treatment system that is installed on available land space on the terminal, and will pipe  
 \*\*\*CARB Staff made the following assumptions for selecting a bonnet capture system that will direct exhaust gas onshore for treatment

1. Sending the auxiliary engine/boiler exhaust to an onshore situated treatment facility (instead of located on the berth) would not violate the intrinsic concerns raised by industry of situating a high
2. CARB staff assumes that terminals with more than one berth would route the emissions from each bonnet to a single, appropriately scaled emissions treatment facility onshore.
3. Even though CARB staff assumes the bonnet capture system with a crane will be the most likely control option for tankers, this does not preclude the terminals or vessels from employing a