

Oakland Seaport Facilities

Siting or expanding seaport facilities, in, or near, communities already highly impacted by diesel pollution, carries a responsibility to build and operate a state-of-the-art facility with emissions as close to zero as technologically possible. Future port projects should include emerging zero emission technology for the trucks, locomotives, ship, tug boats, transport refrigeration units and support equipment that may serve, or operate, at ports. The City of Oakland (City) and Port of Oakland (Port) should take advantage of the planned construction and operational expansion to introduce changes that will lay the foundation for this technology and reduce regional emissions, minimize criteria pollutants and toxic air contaminants as well as the localized health risk from the Port's current and future operations. All projects should require the use of the cleanest technologies, support and encourage the development and demonstration of advanced technologies, with the ultimate goal of requiring the use of zero and near-zero emission technologies as soon as they are available. This requirement for the cleanest equipment is consistent with the City and the Port commitments made in the 2010 document, *A Bold Vision: Redeveloping the Former Oakland Army Base* ("A Bold Vision") and the 2009 *Maritime Air Quality Improvement Plan* (MAQIP).

The following actions need to be taken to ensure that Port operations or construction activities do not increase cumulative air quality impacts now or in the future.

1. Port-Wide Actions

- 1.1. Require that all tenants and onsite construction contractors comply with and monitor compliance with all applicable air quality regulations for heavy duty-diesel trucks, including the Air Resources Board's (ARB) Tractor-Trailer Greenhouse Gas Reduction Regulation, Period Smoke Inspection Program, Off-Road Regulation, and Statewide Truck and Bus Regulation. To document compliance, require that fleets provide ARB Certificates of Compliance for the equipment regulations and copies of annual smoke test results.
- 1.2. Incorporate contractual language into tenant lease agreements to ensure that tenants comply with all applicable air quality regulations, are using the cleanest technologies for their equipment (in both construction and operations) and understand their responsibilities of building and maintaining a green facility as well as compliance with diesel regulations.
- 1.3. Require that the cleanest possible construction practices and equipment are utilized. This should include eliminating idling of diesel powered equipment, requiring the use of zero and near-zero emission equipment and tools to the greatest extent feasible, and providing the necessary infrastructure, like electric hookups, to support that equipment.
- 1.4. Implement and plan accordingly for the necessary infrastructure to support zero emission and near-zero emission technology vehicles and equipment at

the Port. This includes physical, energy, and fueling infrastructure for construction equipment, on-site vehicles, and equipment, and medium-heavy and heavy-heavy duty trucks. ARB's Technology and Fuels Assessments provide information on the current and projected development of mobile source technologies and fuels, including current and anticipated costs at widespread deployment. The assessments can be found at <http://www.arb.ca.gov/msprog/tech/tech.htm>.

At a minimum, both the Port and City should adopt targets for electric raceway circuit installation as part of initial facility construction. This will ensure sufficient electrical power is available for EV charging at sites under development and minimizes future costs to install infrastructure for zero and near zero emissions vehicles.

- 1.5. Develop a Sustainable Leasing Program whereby the Port and City shall work with tenants to develop and implement a policy incentive-based sustainable leasing program to attract the cleanest ships, ships that utilize shore power, zero and near-zero technologies, and otherwise incorporate technological and operational practices that reduce freight related emissions.
- 1.6. Require tenants to use cleaner technologies over time as they become available and feasible. This can be accomplished by requiring tenants to develop an annual Technology Review Program to identify any new emissions-reduction technologies that may reduce emissions at the Port, including the feasibility of zero and near-zero emissions technologies for heavy-duty trucks, yard equipment, tugs, vessels, and bulk handling equipment. If the technology review demonstrates the new technology will be effective in reducing emissions and the Port or City determines that installation or use of the technology is feasible, the tenant shall implement such technology within 12 months of the Port or City's determination (see Appendix A for examples of possible Technology Review Program projects).
- 1.7. Ensure existing and future tenants are compliant now and in the future with ARB's Transport Refrigeration Regulation. If not already implemented, incorporate operating practices that eliminate the amount of time that a transport refrigeration system powered by a fossil-fueled internal combustion engine can operate utilizing the combustion system at the Port. Furthermore, plan and design cold storage facilities that incorporate zero emission all-electric plug-in transport refrigeration systems, hydrogen fuel cell transport refrigeration, and cryogenic transport refrigeration sufficient to meet Port growth.
- 1.8. Require the use of cargo handling equipment (CHE), including yard trucks, handlers, gantry cranes, fork lifts, that is the cleanest available technology (LPG/LNG, renewable diesel, electric, hydrogen, electric hybrid) and use zero and near-zero emission technology for equipment that is commercially

available now and in the future, as more zero-emission equipment becomes commercially available, as committed to in *A Bold Vision*. ARB's Technology Assessment: Mobile Cargo Handling Equipment, provides information on current and projected development of CHE, including current and anticipated costs at widespread development. This assessment can be found at https://www.arb.ca.gov/msprog/tech/techreport/che_tech_report.pdf. Additionally, tenants should be required to demonstrate how their yard lay out maximizes their ability to use zero emissions equipment such as electric rail mounted gantry cranes.

- 1.9. Require the use of commercial harbor craft (CHC) technologies that exceed the Tier 2 or 3 requirements of CARB's CHC Regulation. There are some zero and near-zero emissions technology for equipment that is commercially available now, and additional projects are underway demonstrating the capability of CHC to achieve emission lower than Tier 4 marine and off-road emission standards. Some of these solutions may require retrofit with aftermarket emission control devices. ARB's Technology Assessment: Commercial Harbor Craft, provides information on current and projected development of CHC, including current and anticipated costs at widespread development. This assessment can be found at https://www.arb.ca.gov/msprog/tech/techreport/draft_chc_technology_assessment.pdf.
- 1.10. Require that all medium-heavy and heavy-heavy duty on-road and yard trucks, including any alternative fuel vehicles, meet or exceed the 2010 emission standards. Support the deployment of zero and near-zero technologies including utilizing zero emission (such as battery electric or fuel cell electric) forklifts, electrified rail mounted gantry cranes, and battery electric and hybrid electric medium-duty trucks to the fullest extent feasible. At a minimum, all forklifts should be required to meet a zero emission standard. As it becomes available, require that medium-heavy and heavy-heavy duty trucks traveling within 100 miles of the site use zero and near-zero technology and require that yard trucks with similar duty cycles (less than hundred miles daily) convert to zero and near-zero technology. ARB's Technology and Fuels Assessments provide information on the current and projected development of mobile source technologies and fuels, including current and anticipated costs at widespread deployment. The assessments can be found at <http://www.arb.ca.gov/msprog/tech/tech.htm>.
- 1.11. During all construction activities, require that off-road construction equipment meet Tier 4 engine standards, if not available, require equipment that meets Tier 3 engine standards. Tenants shall keep a list of available equipment and submit to the Port or City upon request.
- 1.12. Require that all on-site service vehicles, light-duty vehicles and equipment (operational and during construction activities), and property maintenance

equipment use zero emission technology and, if zero-emission technology is unavailable, that all vehicles and equipment meet the cleanest applicable emission standard.

- 1.13. Require that all projects include a robust traffic plan that moves truck traffic away from residents reducing truck traffic in neighborhoods, reduces and enforces truck speeds to reduce exposure to noise and increase safety, and discourages new development near truck routes. Coordinate and consult with the West Oakland community on site-wide truck traffic circulation.
- 1.14. Properly integrate truck parking, terminal parking, security systems, electronic gates systems, and other freight transport infrastructure to maximize achievable efficiencies.
- 1.15. Require future project design plans include operational support to demonstrate and deploy zero and near-zero emission freight equipment.
- 1.16. Require ships that enter the Port area pay emissions-based berthing fees or other user fees. The fees shall be used to reduce emissions and exposure in West Oakland.
- 1.17. Require that ocean-going vessels comply with fuel requirements for both the California Ocean-Going Vessel Regulation and the North American Emission Control Area Requirements.
- 1.18. Provide support (logistical and financial) for demonstration projects to encourage the use of alternative and/or advanced technologies. ARB's Technology and Fuels Assessments provide information on the current and projected development of mobile source and port equipment technologies and fuels, including current and anticipated costs at widespread deployment. The assessments can be found at <http://www.arb.ca.gov/msprog/tech/tech.htm>.
- 1.19. Utilize concepts to enhance community engagement as outlined in the U.S. Environmental Protection Agency Draft Environmental Justice Primer for Ports, "The Good Neighbor Guide to Building Partnerships and Social Equity" released in July 2016. This document provides a road map to assess current community engagement and outlines strategies to assist the City and the Port to enhance neighboring community relationships. The document can be found at <https://www.epa.gov/ports-initiative/draft-environmental-justice-primer-ports>
- 1.20. Utilize grant funding from Federal, State and local programs to reduce air pollution emissions and health risk from diesel exhaust. Incorporate a collaborative process between tenants and the Port and/or the City to apply for funding to support zero-emission freight related diesel equipment technologies.
- 1.21. Require that all recycling facilities and metal melting facilities that include re-

melting furnaces for the melting of alloys, within the Port, the OAB project area, and within 1,000 feet of the West Oakland community meet the best available control technology (BACT) standards as defined by the BAAQMD.

2. Former OAB – Both City of Oakland and Port Owned Areas

Below are measures that will help the City and Port meet the requirements of the Oakland Army Base 2013 Standard Conditions of Approval and Mitigation Monitoring and Reporting Program (SCA/MM). *Note:* the City and Port must reduce emissions at the OAB property *beyond* what is required by CARB regulations to meet the requirements of the SCA/MM. These measures also are consistent with measures in the *Maritime Air Quality Improvement Plan* (MAQIP), A Bold Vision, the City of Oakland's Standard Condition of Approval, and air quality mitigation measures in the Environmental Impact Report for 2013 *Plan Bay Area*. When measures are adapted from specific sources, these sources are noted in parenthesis.

The City and Port shall implement all measures listed under Item 1 Port-Wide Activities as applicable, and in addition shall implement the following measures:

- 2.1. All trucks shall be prohibited from idling more than two minutes when loading and unloading, staging or when not in active use for extended periods of time. Exemptions from the two-minute idling rule would be allowed when required for safety or when equipment is in use. (Plan Bay Area)
- 2.2. An appointment/ITS system shall be implemented that minimizes truck idling and queuing for the movement of containers.
- 2.3. Prior to implementation of zero-emission harbor craft described in Item 1.9 above:
 - 2.3.1. Prior to 2023, all CHC accessing the new OAB port facilities will meet USEPA Tier 4 standards (or cleaner) for both propulsion and auxiliary engines, or zero emissions technologies such as: batteries, shorepower, or hydrogen fuel cell.
 - 2.3.2. NOx emissions can be controlled with selective catalytic reduction systems. For example, implement emission reduction control measures to replace tugboat engines with low NOx technology (for example, through the expansion of the existing cargo handling equipment re-powering and retrofitting program, part of the Berths 55-58 Project air quality mitigation program).
- 2.4. All the mobile cargo handling equipment will be electric equipment. (MAQIP)
The Air District suggest this be broadened to allow for other zero emissions fuels

(Hydrogen) and for near zero emissions equipment in the event that full zero emissions equipment is not commercially available.

- 2.5. Buildings shall meet LEED Platinum certification standards. All buildings shall provide sources of energy. Solar, wind, mechanical, tidal or solar generated hydrogen systems will be investigated to determine their feasibility.
- 2.6. The developer shall be required to plant trees and/or vegetation throughout the OAB. Trees that are best suited to trapping PM shall be planted, including one or more of the following: Pine (*Pinus nigra* var. *maritima*), Cypress (*X Cupressocyparis leylandii*), Hybrid poplar (*Populus deltoids* X *trichocarpa*), and Redwoods (*Sequoia sempervirens*). (Plan Bay Area)
- 2.8. All existing land uses serving sensitive receptors within 1,000 feet of the Project boundaries shall be equipped with HEPA air filtration systems rated MERV 13 or better. The Port and City will establish a fund and contribute on a fair share basis to the cost of installing and maintaining the MERV 13 systems and provide educational materials to owners and occupants explaining how to maximize the benefits of these systems.
- 2.9. Consistent with SCA/MM 4.4-5, when redevelopment activity generates more than 20,000 square feet of employment-generating land uses, or generates 100 or more local jobs, the City, Port and developers will fund on a fair share basis Transportation Control Measures (TCMs) for reducing vehicle emissions from commercial, institutional, and industrial operations. See SCA/MM 4.4-5 for a full list of TCMS and include the following:
- 2.10. Commute Benefits Program
 - 2.10.1 To design and implement a Commute Benefits Program, the City, Port, and private developers need to form a committee and assign a representative to the committee. Committee representatives will include two West Oakland community members, an employee representative, and a representative from the Port and from the City. (Note that all employers with 50 or more full-time employees in the Bay Area are subject to the Bay Area Commuter Benefits Program [BAAQMD regulation 14, Rule 1]. For more information, please see <https://commuterbenefits.511.org>)
 - 2.10.2 Design and locate buildings to facilitate transit access, e.g., locate building entrances near transit stops, and eliminate building setbacks. Construct transit facilities such as bus turnouts/bus bulbs, benches, shelters, and improving transit bus service to the area. Provide on-site services, such as cafeterias, banks, dry cleaners, and convenience market so that employees can walk to these services. Include bicycle and pedestrian facilities in the design.

2.10.3 Transit, Bicycle and Pedestrian Access: Include sidewalks, multi-use paths and bike lanes in the project design. Provide secure, weather-protected bicycle parking for employees, Provide showers and lockers for employees bicycling or walking to work. Provide safe, direct access for bicyclists to adjacent bicycle routes. Provide direct, safe, attractive pedestrian access from project to transit stops and adjacent development.

2.10.4 Manage Travel Demand and Provide Transit Service: Encourage OAB tenants to use carpools, vanpools, and public transit by providing incentives. Provide a shuttle to and from the West Oakland BART station. Establish mid-day shuttle service for worksite to food service establishments/commercial areas. Provide preferential parking for carpool and vanpool vehicles. Implement parking fees for single occupancy vehicle commuters.

2.11. New Stationary Sources

2.11.1 On the OAB property, new stationary sources that are added as part of the project must reduce emissions beyond what is required by CARB and BAAQMD, whenever possible. For example, the cleanest available stand-by diesel generators and portable generators will be required. The City and Port shall fund this on a fair share basis.

3. **Former OAB -City of Oakland Owned Areas**

West Gateway Bulk Terminal (Marine Terminal and Rail Expansion)

- 3.1. Implement all applicable site-wide actions based on specific operations in this subject area.
- 3.2. Specify the public review release date and expected content for each of the remaining Subject Plans for this project, subject to Mitigation Measure PO-1 (Stakeholder Review of Air Quality and Trucking Plans). It is expected that the remaining Subject Plans will be released in a timeframe that will allow for meaningful public review and response by the City of Oakland, or project developer, prior to when they are scheduled according to the approved SCA/MM. The list of Subject Plans can be found on page 46 in SCA/MM at <http://www2.oaklandnet.com/oakca1/groups/ceda/documents/report/oak042281.pdf>
- 3.3. Require that berths providing shore power now or in the future, can accommodate changes to vessel sizes and various berthing configurations. The ARB At-Berth Regulation currently requires 80% compliance of ocean going vessels by 2020. Vessel operations should meet 100 percent shore power compliance rate for all vessels or incorporate other technologies, such as emissions capture and control systems, to maximize emission reductions from

all vessels in advance of the regulation. ARB's Sustainable Freight: Pathways to Zero and Near-Zero Emissions Discussion Document has identified the development and proposal of amendments to the At-Berth that could expand the regulation to include smaller fleets and/or additional vessel types to the current At Berth Regulation. Additionally, hybrid technologies have shown success at achieving emission reductions in certain tugs based on duty, engine size, and location and should be incorporated into operations, where possible.

Accelerate the turnover of line-haul locomotives servicing the Port to Tier 4 line-haul, ARB proposed Tier 5, or Zero emissions locomotives as expeditiously as possible, with the goal of 95 percent of operations to be performed at a minimum Tier 4 standard by 2023. In addition establish standards that require:

- 3.4.1. All diesel switch engines to have 15-minute idling limit devices installed and operational; and to use emulsified fuels or other equivalently clean alternative diesel fuel.
 - 3.4.2. No non-essential idling. Class 1 helper locomotives will be turned off while on OAB properties. If, for safety reasons, helper locomotives need to be on then they will meet similar control requirements as line haul locomotives.
- 3.4. The Port, Union Pacific (UP) Railway, and/or BNSF Railway should commit to providing co-funding, facility access, and operational support for the development and demonstration of interstate line-haul locomotive technology with zero-emission capability. This would include, but is not limited to, a hybrid-electric locomotive with all electric capability. ARB's Technology Assessment: Freight Locomotives, provides information on current and projected development of freight locomotives, including current and anticipated costs at widespread development. This assessment can be found at https://www.arb.ca.gov/msprog/tech/techreport/freight_locomotives_tech_report.pdf
- 3.5. Incorporate conditions into lease agreements with BNSF and/or UP to ensure that switch locomotives meet a minimum Tier 4 emissions level by 2023.
 - 3.6. Phase in the replacement of diesel powered switcher locomotives with electric rail car movers, within the Port or City owned rail properties.

Prologis East and Central Gateway (Ambient Transload/Warehouse/Truck Services)

- 3.7. Implement all applicable site-wide actions based on specific operations in this subject area.

North Gateway (Recycling and Rail Right Of Way Expansion)

- 3.8. Implement all applicable site-wide actions based on specific operations in this subject area.

4. Former OAB Port of Oakland Owned Areas

Central Gateway (Ambient Transload/Warehouse/Rail Yard /Port Logistics/Warfs)

- 4.1. Implement all applicable site-wide actions based on specific operations in this subject area.
- 4.2. Specify the public review release date and expected content for each of the remaining Subject Plans for this project, subject to Mitigation Measure PO-1 (Stakeholder Review of Air Quality and Trucking Plans). It is expected that the remaining Subject Plans will be released in a timeframe that will allow for meaningful public review and response by the City of Oakland, or project developer, prior to when they are scheduled per the SCA/MM. The list of Subject Plans can be found on page 46 in SCA/MM at <http://www2.oaklandnet.com/oakca1/groups/ceda/documents/report/oak042281.pdf>.

5. Port of Oakland (Non-Former OAB Areas)

Cool Ports Oakland, LLC (Temperature Controlled Transload/Warehouse/Rail Expansion)

- 5.1. Implement all applicable site-wide actions based on specific operations in this subject area.
- 5.2. Ensure existing and future tenants are compliant now and in the future with ARB's Transport Refrigeration Regulation. Incorporate operating practices that eliminate the amount of time that a transport refrigeration system powered by a fossil-fueled internal combustion engine can operate utilizing the combustion system while at the Port. Require the use of zero emission all-electric plug-in transport refrigeration systems and ensure the design plan includes the necessary infrastructure. ARB's Technology Assessment: Transport Refrigerators, provides information on the current and projected development for transport refrigerators, including current and anticipated costs at widespread deployment. This assessment can be found at https://www.arb.ca.gov/msprog/tech/techreport/tru_07292015.pdf.
- 5.3. Accelerate the turnover of line-haul locomotives servicing the Port to Tier 4, ARB proposed Tier 5, or Zero emissions locomotives as expeditiously as possible, with the goal of 95 percent of operations to be performed at a minimum Tier 4 standard by 2023. Furthermore, the Port, Union Pacific (UP) Railway, and/or BNSF Railway should commit to providing co-funding, facility access, and operational support for the development and demonstration of

interstate line-haul locomotive technology with zero-emission capability. This would include, but is not limited to, a hybrid-electric locomotive with all electric capability. ARB's Technology Assessment: Freight Locomotives, provides information on current and projected development of freight locomotives, including current and anticipated costs at widespread development. This assessment can be found at

https://www.arb.ca.gov/msprog/tech/techreport/freight_locomotives_tech_report.pdf.

- 5.4. Incorporate conditions into lease agreements with BNSF and/or UP to ensure that switch locomotives meet a minimum Tier 4 emissions level by 2023.
- 5.5. Phase in the replacement of diesel powered switcher locomotives with electric rail car movers, within the Port or City owned rail properties.
- 5.6. Plan and design for the necessary infrastructure to ensure 100 percent, plug-in equipped, to accommodate future growth volumes of TRU's or expansion of this area.
- 5.7. Implement a policy that limits the amount of time that a transport refrigeration system powered by a fossil-fueled internal combustion engine can operate utilizing the combustion system while on Site.
- 5.8. Encourage the use of zero emission all-electric plug-in refrigeration systems, hydrogen fuel cell and cryogenic transport refrigeration systems.
- 5.9.

Port Terminal/Maritime Operations (Inner, Middle, Outer Harbors, and Seventh Street)

- 5.10. Implement all applicable site-wide actions based on specific operations in this subject area.
- 5.11. Accelerate the turnover of line-haul locomotives servicing the Port to Tier 4, ARB proposed Tier 5, or Zero emissions locomotives as expeditiously as possible, with the goal of 95 percent of operations to be performed at a minimum Tier 4 standard by 2023. Furthermore, the Port, Union Pacific (UP) Railway, and/or BNSF Railway should commit to providing co-funding, facility access, and operational support for the development and demonstration of interstate line-haul locomotive technology with zero-emission capability. This would include, but is not limited to, a hybrid-electric locomotive with all electric capability. Incorporate conditions into lease agreements with BNSF and/or UP to ensure that switch locomotives meet a minimum Tier 4 emissions level by 2023. ARB's Technology Assessment: Freight Locomotives, provides information on current and projected development of freight locomotives, including current and anticipated costs at widespread development. This

assessment can be found at

https://www.arb.ca.gov/msprog/tech/techreport/freight_locomotives_tech_report.pdf.

- 5.12. Phase in the replacement of diesel powered switcher locomotives with electric rail car movers, within the Port or City owned rail properties.
- 5.13. Require that berths providing shore power now or in the future, can accommodate changes to vessel sizes and various berthing configurations. The ARB At-Berth Regulation currently requires 80% compliance of ocean going vessels by 2020. Vessel operations should meet 100 percent shore power compliance rate for all vessels or incorporate other technologies, such as emissions capture and control systems, to maximize emission reductions from all vessels in advance of the regulation. ARB's Sustainable Freight: Pathways to Zero and Near-Zero Emissions Discussion Document has identified the development and proposal of amendments to the At-Berth that could expand the regulation to include smaller fleets and/or additional vessel types to the current At Berth Regulation. Additionally, hybrid technologies have shown success at achieving emission reductions in certain tugs based on duty, engine size, and location and should be incorporated into operations, where possible.

Appendix A

Technology Review Program

Development of a Technology Review Program is consistent with the requirements of Mitigation Measures in the Oakland Army Base 2013 Standard Conditions of Approval and Mitigation Monitoring and Reporting (SCA/MM) Program. Below are recommended Technology Review Programs that can be implemented to reach the goals of the SCA/MM.

In consultation with regional agencies and stakeholders, the City and Port shall implement Technology Review Programs, such as:

- The City and Port should administer a minimum of a one year demonstration project, prior to 2020, of zero and near-zero emission truck technology. This demonstration project shall be conducted in cooperation with regional and state agencies and stakeholders.
- Research and funds shall be used to identify and test hybrid diesel electric locomotives and conduct a demonstration of locomotive DOC or DPF retrofits.
- Feasibility studies of electrification of freight/passenger rail from Port intermodal yards to the Bay Area Air Quality Management District's boundaries conducted in conjunction with the Metropolitan Transportation

Commission, Capital Corridor JPA, Union Pacific, and Burlington Northern Santa Fe railroads.

- Investigation of renewable energy generation via mechanical systems that utilize truck weight to generate electricity.
- Study of a “virtual container yard” system that integrates truck movements with container moves to minimize emissions and maximize efficient use of trucking fleets.

Example TAP Studies

As a possible framework for the Technology Review Program, consider the work of the San Pedro Ports Technology Advancement Program (TAP). TAP is a joint program of the Ports of Long Beach and Los Angeles through the Ports’ joint Clean Air Action Plan (CAAP) adopted in 2006. The CAAP guides the Ports in their commitment to reduce the health risks and air emissions associated with port-related operations, while allowing port development and growth to continue. The CAAP focuses on near-term strategies, targeting significant reductions in diesel PM, nitrogen oxides (NOx), and sulfur oxides (SOx). The following is a selected list of demonstration projects completed through the TAP program:

- Balqon E-30 Electric Terminal Tractor Development and Demonstration Project

This vehicle was built as a demonstration vehicle and designed specifically for drayage operations. The prototype E-30 all-electric terminal tractor successfully completed cargo terminal tests in 2008.

Following the completion of cargo terminal tests during 2008, the Los Angeles Harbor Commission approved the purchase of 20 electric trucks from the manufacturer as part of the “Green Terminal” program. The Green Terminal program will also include the production of five on-road electric trucks.

This demonstration project was followed with a project to evaluate and demonstrate a lithium-ion battery as a technological upgrade to the lead-acid battery pack used in the previous TAP demonstration. The advanced technology lithium-ion batteries were anticipated to provide more than double the vehicle range, without adding additional weight. A one-day demonstration of the Nautilus E30 confirmed a range of over 150 miles on a single charge with unloaded conditions at 80% depth of discharge. However, this project was never completed.

- Capacity Plug-In Hybrid Electric Terminal Tractor (2010)

The TAP program conducted a three-week trial of a diesel-electric plug-in hybrid terminal tractor that uses a small diesel generator and a large lead-acid battery pack to provide power for vehicle operation. While this demonstration showed a 44

percent reduction in NOx emissions and a 56 percent reduction in PM emissions, compared to 2009 diesel yard tractors, the demonstration utilized a Tier 4-interim generator drive engine, and therefore does not meet CARB's Cargo Handling Equipment regulation of Tier 4 engines.

- Hybrid Yard Tractor Development & Demonstration (2010)

This TAP study investigated the feasibility and commercial viability of using advanced technology drive systems in cargo handling equipment. The three hybrid yard hostlers underwent six months of operation and in-use testing and could perform all the tasks required of yard hostlers in real-world port operations, and were well accepted by drivers and maintenance staff. Fuel economy and emissions benefits were evaluated, but a difference discovered in the mechanical specifications of the vehicles limited comparability. Based on all the evaluations and analyses conducted, the hybrid system is estimated to provide a 12 percent to 18 percent improvement in fuel economy. Further development of the hybrid system is underway to improve fuel economy and emissions reductions. A follow-up study was conducted entitled "Hybrid Yard Tractor Development and Demonstration – Beta Test".

- Alternative Petroleum Technologies (APT) Emulsified Biodiesel Fuel Demonstration (2011)

To demonstrate the viability and effectiveness of the emulsified biodiesel fuel in cargo handling equipment, APT performed a two-phased demonstration that consisted of an evaluation of the emulsified fuel with and without a diesel oxidation catalyst (DOC) in a laboratory setting and a real-time demonstration of the fuel in yard equipment at a port terminal.

The demonstration successfully proved that APT's emulsified B-20 blend mitigated an increase in NOx emissions, while also providing additional reductions in PM when coupled with a verified diesel emissions control system. This provides port drayage operators an alternative fuel selection for their existing fleet of container yard equipment.

As of April 2014, APT planned to pursue CARB verification of the emulsified biodiesel fuel for sale to existing cargo handling equipment fleet operations in the State.

- Liquefied Natural Gas Yard Tractor Demonstration (2007)

This Project was designed to develop, test and design a business case for LNG yard tractors. Phase 1 focused on development of LNG yard tractor specifications, procurement, and installation of temporary LNG refueling. Phase 2 included operation of the LNG yard tractors at a marine terminal for a period of eight months. Phase 3 of the project was the development of a business case assessment to

determine the cost effectiveness and return on investment of using LNG equipment as opposed to diesel.

During emissions testing, the LNG yard tractor produced lower PM emissions than on-road diesel engine equipped with a diesel oxidation catalyst and closed crankcase ventilation system. However, NO_x emissions from the LNG yard tractor were approximately 21 percent higher than NO_x emissions from this same on-road diesel engine configuration.

- ACTI Advanced Maritime Emission Control System (AMECS) Project (2008)

ACTI developed the AMECS as an alternative pollution control method for ocean-going vessels that are not configured to use shore power, also known as “cold ironing”, while at berth. The goal was to demonstrate pollution reduction efficiencies equal to cold ironing for nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulate matter (PM). The AMECS was demonstrated at Metropolitan Stevedore/Port of Long Beach on multiple vessels with varying exhaust stack configurations. During the demonstration period, two full-scale emission reduction efficiency tests were conducted, the results of which were independently verified by two testing laboratories. During emissions testing, NO_x and PM emissions were reduced by 99 percent and 95.5 percent, respectively. In addition, sulfur oxides (SO_x) were reduced by 99 percent, and volatile organic compound (VOC) emissions were reduced by greater than 97 percent. Further demonstration of this technology is necessary to determine how it functions in day-to-day operations, including evaluation of costs, durability, integration into operations.

- APL Singapore Slide Valve & Water-In-Fuel (WiFE) Emulsion Demonstration Program (2009)

Two emission control technologies were demonstrated - the use of slide valves in the vessel's main engines, and water-emulsified bunker fuel using an innovative onboard water in fuel emulsifier. The primary objectives of the demonstration projects were to a) evaluate the particulate matter (PM) emission reduction effectiveness of retrofitting OGV main engines with an improved injector design known as a slide valve; and b) demonstrate demand-based onboard water in fuel emulsification system and measure the NO_x reduction effectiveness of varying the water content.

Project test conditions resulted in an evaluation that indicated the benefits of slide valves appear to be limited. Testing of the WiFE system aboard the APL Singapore showed water concentrations as high as 48 percent were successfully demonstrated, yielding NO_x reductions on the order of 30 percent. A further study was completed in 2012.

- Bluefield Holdings Krystallon Ocean Going Vessel Scrubber (2013)

The primary focus of this project was to demonstrate the reduction of emissions of sulfur oxides (SO_x) from an Ocean Going Vessel using an exhaust gas cleaning device to meet the International Maritime Organization (IMO) fuel sulfur limits in Emission Control Areas (ECA) and further to reduce particulate matter (PM), and volatile organic compound (VOC) emissions. This project demonstrated the potential for PM and SO_x reductions that can be achieved through OGV retrofit using commercially available scrubbing technology. Additional research is needed further evaluate the potential for OGV engine emission reductions from scrubbers on main engines to comply with IMO ECA regulations.

- Foss Maritime Green Assist™ Hybrid Tugboat (2010)

Foss Maritime developed this diesel electric hybrid tugboat and named it the *Carolyn Dorothy*. The *Carolyn Dorothy* became a full working member of the Foss Maritime tug fleet on March 1, 2009. Since this time, the hybrid tug demonstrated performance comparable to a conventional Dolphin Class tugboat. The hybrid tugboat achieved emission reductions that exceed original targets (to reduce both NO_x and PM by approximately 44 percent) when compared with the Dolphin tugs currently operating in the San Pedro Bay. The *Carolyn Dorothy* reduced PM, NO_x and CO₂ emissions by 73 percent, 51 percent and 27 percent, respectively. Based on this evaluation, there is evidence that this technology reduces fuel consumption by approximately 20 to 30 percent.

- OGV Slide Valve Low-Load Emissions Evaluation (2013)

This project is a follow up to the 2008 demonstration of a slide-type fuel valves, and sought to test a new type of OGV main engine fuel valve (SV C36) designed to improve combustion properties by eliminating sac volume (i.e., fuel drips) at the valve nozzle. The elimination of the sac volume results in lower fuel oil consumption. In addition, slide valve nozzles incorporate an optimized spray pattern designed to improve the combustion process - this is intended to reduce overall emissions, including hydrocarbon, NO_x and particulate matter. The visible smoke level is also greatly reduced because of the improved combustion. Among other findings, results showed that SV C26 nozzles did emit less diesel particulate matter (DPM) at low loads compared to the two conventional fuel valve configurations. At low loads, SV emits up to 50 percent less DPM than conventional C3 and C11 fuel valves and up to 65 percent less DPM for cylinder-lubrication-corrected particulate-emission results. Overall, SV C26 nozzles emit over 90 percent less total hydrocarbons compared to the two conventional fuel valve configurations.

California Energy Commission Projects

In addition to the emissions reduction studies that are being undertaken as part of the TAP, the California Energy Commission (Energy Commission) released a Grant Solicitation for “Sustainable Freight Transportation Projects” under the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). This grant

solicitation funded projects that demonstrate medium- and/or heavy-duty advanced vehicle technologies at California seaports. The three projects selected as part of this solicitation propose to demonstrate:

- 9 zero emissions rubber tired gantry cranes
- 15 battery electric yard tractor's
- 7 natural gas hybrid electric trucks
- 3 zero emissions top handlers
- 20 near zero natural gas trucks

Results of these demonstrations should inform the Technology Review Program established as part of the Oakland Army Base 2013 SCA/MM Program.

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