STATE OF CALIFORNIA
California Environmental Protection Agency
AIR RESOURCES BOARD
ASD/BCGB-337 (NEW 10/2017)

GRANT AGREEMENT COVER SHEET

	GRANT NUMBER G16-DEMO-08
NAME OF GRANT PROGRAM Zero-Emissions Track-Miles Locomotive Demonstration	
GRANTEE NAME The City of Los Angeles Harbor Department	
TAXPAYER'S FEDERAL EMPLOYER IDENTIFICATION NUMBER 95-6000735	TOTAL GRANT AMOUNT NOT TO EXCEED $2,768,830.00
FISCAL GRANT TERM FROM: May 30, 2018	TO: March 30, 2020
PROJECT PERFORMANCE PERIOD OF GRANT AGREEMENT FROM: May 30, 2018	TO: March 30, 2020

This legally binding Grant Agreement, including this cover sheet and Exhibits attached hereto and incorporated by reference herein, is made and executed between the State of California, California Air Resources Board (CARB) and the City of Los Angeles Harbor Department (the "Grantee").

Exhibit A – Grant Provisions
Exhibit B – Work Statement, incorporating the following attachments: Attachment I-Budget Summary, Attachment II-Project Milestones and Disbursement Schedule, Attachment III-Project Schedule and Attachment IV-Key Project Personnel
Exhibit C – Grant Solicitation Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program: Off-Road Advanced Technology Demonstration Projects
Exhibit D – Grantee Application Package

This Agreement is of no force or effect until signed by both parties. Grantee shall not commence performance until it receives written approval from CARB.

The undersigned certify under penalty of perjury that they are duly authorized to bind the parties to this Grant Agreement.

California Air Resources Board		GRANTEE'S NAME (PRINT OR TYPE) The City of Los Angeles Harbor Department	
SIGNATURE OF CARB'S AUTHORIZED SIGNATORY:		SIGNATURE OF GRANTEE (AS AUTHORIZED IN RESOLUTION, LETTER OF COMMITMENT, OR LETTER OF DESIGNATION)	
TITLE Administrative Services Branch Chief, CARB	DATE	TITLE Executive Director	DATE
		GRANTEE'S ADDRESS (INCLUDE STREET, CITY, STATE AND ZIP CODE) 425 S. Palos Verdes St. San Pedro, CA 90731	

CERTIFICATION OF FUNDING

AMOUNT ENCUMBERED BY THIS AGREEMENT $2,768,830.00	FISCAL YEAR/PROGRAM 2016/17 / 3510			FUND TITLE *Greenhouse Gas Reduction Fund*
PRIOR AMOUNT ENCUMBERED FOR THIS AGREEMENT $0.00	(OPTIONAL USE)			
TOTAL AMOUNT ENCUMBERED TO DATE $2,768,830.00	ITEM 3900-101-3228	CHAPTER 370	STATUTE 2016	FISCAL YEAR 2016/17
	OBJECT OF EXPENDITURE 6100-702-57207			

I hereby certify that the California Air Resources Board Budget Office acknowledges that budgeted funds are available for the period and purpose of the expenditure stated above.

SIGNATURE OF CALIFORNIA AIR RESOURCES BOARD BUDGET OFFICE:	DATE 5/1/18

I hereby certify that the California Air Resources Board Legal Office has reviewed this Grant Agreement.

SIGNATURE OF CALIFORNIA AIR RESOURCES BOARD LEGAL OFFICE:	DATE 5/1/18

RECEIVED IN BUDGETS

APR 30, 2018 4:20PM

GRANT AGREEMENT

Zero-Emission Track-Miles Locomotive Demonstration

Mobile Source Control Division
California Air Resources Board
[INSERT: Date of CARB Signature]

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

CALIFORNIA
AIR RESOURCES BOARD

GRANT PROVISIONS

A. This grant is from the California Air Resources Board (hereinafter referred to as CARB) to the City of Los Angeles Harbor Department (hereinafter referred to as Grantee).

The parties agree to comply with the requirements and conditions contained herein, as well as all commitments identified in the Grant Solicitation for the Air Quality Improvement Program and Low Carbon Transportation Greenhouse Gas Reduction Fund Investments: Off-Road Advanced Technology Demonstration Projects (Exhibit C) and Grantee Application Package (Exhibit D).

B. The California Climate Investments logo and name serves to bring under a single brand the many investments whose funding comes from the Greenhouse Gas Reduction Fund (GGRF). The logo represents a consolidated and coordinated initiative by the State to address climate change by reducing greenhouse gases, while also investing in disadvantaged communities and achieving many other co-benefits. The Grantee agrees to acknowledge the California Climate Investments program as a funding source from the California Air Resources Board's Low Carbon Transportation program whenever projects funded, in whole or in part by this Agreement, are publicized in any news media, websites, brochures, publications, audiovisuals, or other types of promotional material. The acknowledgement must read as follows: 'This publication (or project) was supported by the "California Climate Investments" (CCI) program.' Guidelines for the usage of the CCI logo can be found at www.arb.ca.gov/ccifundingguidelines.

C. **GRANT SUMMARY AND AMENDMENTS (IF APPLICABLE)**

Project Title: Zero-Emission Track-Miles Locomotive Demonstration

Funding Amount: $2,768,830

Match Amount: $1,064,320

D. GRANT PARTIES CONTACT INFORMATION

1. The CARB Project Liaison is Eloy Florez, Air Pollution Specialist. Correspondence regarding this project must be directed to:

   Eloy Florez, Air Pollution Specialist
   California Air Resources Board
   Mobile Source Control Division
   9480 Telstar Avenue No. 4
   El Monte, California 91731
   Phone: (626) 350-6525
   Email: eloy.florez@arb.ca.gov

   If the CARB Project Liaison identified above changes, CARB will notify the Grantee Liaison of said change and provide the Grantee Liaison with the new CARB Project Liaison's contact information.

2. The Grantee Liaison is Jacob Goldberg, Environmental Specialist. Correspondence regarding this project must be directed to:

   Jacob Goldberg, Environmental Specialist
   Port of Los Angeles
   425 S Palos Verdes St
   San Pedro, CA, 90731
   (310) 732-2675
   Email: jgoldberg@portla.org

   If the Grantee Liaison identified above changes, the Grantee will notify the CARB Project Liaison of said change and provide the CARB Project Liaison with the new Grantee Liaison's contact information.

E. TIME PERIOD

1. Performance of work or other expenses billable to CARB under this grant may commence after signing and awarding of this grant. Performance on this grant ends once the Grantee has submitted the Final Report or if the grant is terminated, whichever is earlier.

2. Upon completion of the project, the Grantee must submit a draft Final Report to the CARB Project Liaison no later than **February 14, 2020** (see Section I.4).

3. The Final Report and final request for payment must be received by CARB no later than **March 30, 2020** (see Section I.4).

4. The CARB Executive Officer retains the authority to terminate or reduce the dollar amount of this grant if by **January 1, 2019**, 45 percent of project funding,

or by **January 1, 2020**, 75 percent of project funding, has not been expended by the Grantee. In the event of such termination, Section J of these provisions apply.

F. SCOPE OF WORK

Description

1. The Port of Los Angeles-Harbor Department (POLA) will demonstrate VeRail Technologies zero-emission battery powered switcher locomotive technology, designed to support the 2,100 horsepower requirements for full operational capability throughout the Pacific Harbor Railine (PHL) network of in-harbor track lines. Typical switcher operations rarely exceed 10 miles per hour (mph) but this demonstration will operate with speeds of 10-15 mph within the port and may exceed 35 mph on the Alameda Corridor, with the intent of proving the technology's capabilities. The advanced technology 14-pod battery bank is rated at 1,820 kilowatt hours (kWh) and will supply enough energy for a typical working shift (8.5-12 hours) without recharging. The zero-emission technology will be demonstrated on VeRail's Near-Zero Emissions Locomotive, which is currently undergoing evaluation as part of a Port Technology Advancement Program demonstration project with South Coast Air Quality Management District, United States Environmental Protection Agency, and the Port of Long Beach. Electric charging infrastructure will be installed to support the demonstration unit at the PHL facility in Wilmington, California.

   The proposed demonstration will encompass a nine-month in-service demonstration that will be monitored by an independent third-party data collection and analysis contracting team consisting of Tetra Tech and University of California, Riverside College of Engineering, Center for Environmental Research and Technology (CE-CERT). Key project objectives include:

   a. Meet goals under the Off-Road Advanced Technology Demonstration Projects Solicitation (Exhibit C) and the Fiscal Year 2016-17 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program;

   b. Conduct an in-service demonstration of battery-powered switcher locomotive operation;

   c. Collect and evaluate demonstration data, including performance metrics and costs;

   d. Assess and project long-term battery life and range; and

e. Assess cost effectiveness based on real-world results and costs (maintenance, capital and operational), to support wider scale commercialization.

Additional Scope of Work detail is in Exhibit B Work Statement and Exhibit D Grantee Application Package, Attachment 2.

General Responsibilities

2. CARB is responsible for the following:

   a. Participation in regular meetings with Grantee to discuss project refinements and guide the administration of the project.

   b. Reviewing and approving project elements provided by Grantee, such as fueling infrastructure permitting, infrastructure design and construction, general vehicle and equipment design criteria, data collection and analysis.

   c. Review and approve all grant disbursement requests (Form MSCD/ISB-90).

   d. Provide project oversight in conjunction with Grantee.

   e. Ensure compliance with applicable requirements of:

      i. Fiscal Year 2016-2017 Funding Plan for the Air Quality Improvement Program and Low Carbon Transportation Greenhouse Gas Reduction Fund Investments (FY 2016-17 Funding Plan), and
      ii. Grant Solicitation Off-Road Advanced Technology Demonstration Project (Exhibit C).

   f. Maintaining adherence to the project timeline.

3. Grantee's responsibilities include all California Environmental Quality Act (CEQA) requirements, project development, project administration, project reporting, project progress, project invoice validation, including the following tasks:

   a. All CEQA requirements, including but not limited to necessary permits and environmental documents, must be completed prior to the execution of the grant agreement. Fulfilling the CEQA requirements includes ensuring that all necessary permits and environmental documents are prepared and that clearances are obtained from the appropriate agencies.

   b. Grantee's key project personnel will participate in an initial project kick-off meeting with CARB staff before work on the project begins. The purpose of the initial meeting will be to discuss the overall plan, details for performing the tasks, the project schedule, and any issues that may need to be addressed.

c. Participate, schedule, and organize regular project update meetings at least quarterly. Grantee's key personnel and data collector will also participate in review meetings to discuss progress. Additional meetings may be scheduled at the sole discretion of the CARB Project Liaison. The regular project update meetings shall include the following items:

   i. An agenda with call-in information for all participants;
   ii. The agenda will detail all the issues to be discussed during the regular project update meeting including items that may cause the project to slip on the time schedule;
   iii. Statement of work expected to be completed by the next status report;
   iv. The project timeline and steps needed to maintain the project timeline;
   v. Itemized listing of match funding totals to date; and
   vi. A discussion on what milestones and workplan tasks are expected to be completed before the next regular project update meeting.

d. The Grantee must submit numbered Status Reports accompanying grant disbursement requests to CARB at least every three months, but may submit on a monthly basis, if necessary, for more frequent disbursements with prior approval from CARB. These reports must be approved by CARB and must contain the following information, at a minimum, in either Microsoft Word or PDF, as a single electronic file:

   i. Project Status Report number, title of project, name of Grantee, date of submission, and project grant number;
   ii. Summary of work completed since the last Status Report, noting progress toward completion of tasks and milestones identified in the workplan;
   iii. Statement of work expected to be completed by the next Status Report;
   iv. Notification of problems encountered and an assessment of their effects on the project's outcome;
   v. Data collected from vehicles and equipment since the last data reporting, as deemed necessary by CARB or the data analysis provider;
   vi. Itemized invoice, or other documentation that has been approved by CARB, showing all costs for which reimbursement is being requested.
   vii. Itemized listing of match funding totals to date;
   viii. Discussion of the project's adherence to the project timeline;
   ix. If the project timeline is not being met, discuss efforts that will be implemented to get the project back on schedule; and
   x. Any interest earned from project funds as detailed in Section G.6., if applicable.

e. Ensure the purchase of advanced technology equipment.

f. Ensure all project milestones and tasks are completed as detailed in Exhibit B, Work Statement and Exhibit D, Grantee Application Package, Attachment 2.

g. Provide CARB with a draft Final Report for comments at least one month before the due date of the Final Report.

h. Ensure that fleets and manufacturers are flexible for the scheduling of the data logging installation, data retrieval, and Portable Emissions Measurement Systems (PEMS) testing, if applicable.

i. Ensure that end-user fleets are working with the data collection provider.

j. Ensure data collected during the demonstration includes all data collection metrics detailed in Exhibit C, Fiscal Year 16/17 Off-Road Advanced Technology Demonstration, Appendix F.

k. Submit a Final Report at the end of the project including results of the data collection. The Final Report must contain a description of the project's goals and objectives, methods, results of the demonstration (with a summary of the status reports), future application of the technology including commercialization prospects, any deliverables that were committed to in the project, and any other information required by CARB.

G. FISCAL ADMINISTRATION

Budget

1. The maximum amount of this grant is $2,768,830. Under no circumstance will CARB reimburse the Grantee for more than this amount. The budget for this project is shown in Exhibit B, Attachment I.

2. The project will include a cash-match and an in-kind match from private, eligible state, and local funding of $1,064,320 to leverage this grant, for a total project budget of $3,833,150.

3. Administrative funding may be reallocated to project funds with prior written approval by CARB.

4. The Grantee Application package is incorporated by reference as part of the Grant Agreement in Exhibit D. The application submitted will be the actual costs for the project and will not be amended due to faulty estimations, increases in costs due to inflation or other reasons that have not been covered in the budget.

5. Subject to prior written approval from CARB, line item shifts in Exhibit B,

Attachment II, of up to ten percent of the grant total may be made over the life of the grant. Line item shifts greater than ten percent require a formal amendment to the grant. Line item shifts may be proposed by either CARB or the Grantee and must not increase the total grant amount. All line item shifts must be approved in writing by CARB. If the grant is formally amended, all line item shifts must be included in the amendment.

Earned Interest

6. Earned interest means any interest earnings generated from grant funds held by Grantee in interest-bearing accounts.

    a. Grant funds are not required to be held in an interest bearing account. However, if interest is earned by Grantee on the project the earnings must be reported to CARB. All interest income on the project funds must be reinvested in and used by the project or returned to CARB. Grantee is responsible for reporting to CARB all project expenditures funded with interest earned on the grant funds.

    b. If applicable, Grantee must maintain accounting records (e.g., general ledger) that tracks interest earned, expended, or returned on the grant funds, as follows:

        i. The calculation of interest must be based on an average daily balance or some other reasonable and demonstrable method.
        ii. Interest earned must ensure that it is separately identifiable from interest earned on non-grant funds.
        iii. The methodology for calculating earned interest must be consistent with how it is calculated for Grantee's other fiscal programs.
        iv. Earned interest must be fully expended or returned to CARB by completion of the project, submittal of the Final Report, or by **January 31, 2020,** whichever comes first.
        v. Documentation of interest earned on the grant funds and expenditures made on those funds or returned to CARB must be:

            (1) Retained for a minimum of three years after it is generated, and
            (2) Provided to CARB in Status Reports and a Final Report.

Grant Disbursements

7. Requests for payment shall be made with the Grant Disbursement Request Form (Form MSCD/ISB-90) and conform to the instructions identified in the Fiscal Year 2016-17 Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program Off-Road Advanced Technology Demonstration Projects Solicitation (Solicitation, Exhibit C) Section XVII, Implementation Process.

Grant payments shall be:

a. Made on a reimbursement basis and only for actual costs incurred by the Grantee;

b. Made only when the Grantee has submitted a Grant Disbursement Request Form; and

c. Made only when the milestones stipulated in Exhibit B, Attachment II have been accomplished and documentation of accomplishment has been provided to CARB in the form of the Status Report and any associated deliverables (if applicable) have been provided to CARB.

CARB will have sole discretion to accelerate the timeline for allowable disbursements of administration and project funds identified in Exhibit B, Attachment II (with the exception of the final project administration disbursement), necessary to assure the goals of the project are met.

8. Grant payments are subject to CARB's approval of Status Reports and any accompanying deliverables (see Section I). A payment will not be made if the CARB Project Liaison deems that a milestone has not been accomplished or documented, a deliverable meeting specification has not been provided, claimed expenses are not documented, not valid per the budget, or not reasonable, or the Grantee has not met other terms of the grant.

   The Division Chief of the Mobile Source Control Division (MSCD) or designee of CARB may review the CARB Project Liaison's approval or disapproval of a grant disbursement request. No reimbursement will be made for expenses that, in the judgment of the Division Chief of MSCD, are not reasonable or do not comply with the Grant Agreement.

9. The Grantee shall mail completed and signed Grant Disbursement Request Forms to the CARB Project Liaison.

10. CARB retains the right to withhold payment of ten percent of administrative funds until completion of all work and submission of a Final Report to CARB. It is the Grantee's responsibility to submit a Grant Disbursement Request Form for this final disbursement of funds.

11. CARB shall disburse funds in accordance with the California Prompt Payment Act, Government Code, Section 927, et seq.

Oversight and Accountability

12. The Grantee shall comply with all oversight responsibilities identified in the Solicitation (Exhibit C), Grantee Application Package (Exhibit D), and this Grant Agreement.

13. CARB or its designee reserves the right to audit at any time during the duration of this grant the Grantee's costs of performing the grant and to refuse payment of any reimbursable costs or expenses that in the opinion of CARB or its designee are unsubstantiated or unverified. The Grantee shall cooperate with CARB or its designee including, but not limited to, promptly providing all information and documents requested, such as all financial records, documents, and other information pertaining to reimbursable costs, and any matching costs and expenses.

14. CARB or its designee may recoup funds which were received based upon misinformation or fraud, or for which a Grantee, manufacturer (including equipment manufacturer), technology provider, or vehicle purchaser is in significant or continual noncompliance with the terms of this grant or State law. CARB also reserves the right to prohibit any entity from participating in Off-Road Advanced Technology Demonstration Projects, due to noncompliance with project requirements.

H. PROJECT MONITORING

Meetings

1. <u>Kick-off meeting</u>: A meeting will be held between key project personnel and CARB staff before work on the project begins. The purpose of the first meeting will be to discuss the overall plan, details of performing the tasks, the project schedule, and any issues that may need to be resolved.

2. <u>Project update meetings</u>: Meetings to discuss progress must be held at least quarterly beginning three months after the kick-off meeting. Additional meetings may be scheduled at the sole discretion of the CARB Project Liaison. Such meetings may be conducted by phone, if deemed appropriate by the CARB Project Liaison.

Technical Monitoring

3. Any changes in the scope or schedule for the project shall require the prior written approval of the CARB Project Liaison and may require a grant amendment.

4. The Grantee shall notify the CARB Project Liaison in writing, immediately if any circumstances arise (technical, economic, or otherwise), which might place completion of the project in jeopardy. In addition, the Grantee shall also make such notification if there is a change in key project personnel (see Exhibit B, Attachment IV).

5. The Grantee shall notify the CARB Project Liaison if the project technology will pursue official verification/certification during the term of this agreement and all documentation in support of the verification/certification must be submitted to the CARB Project Liaison concurrently with the verification/certification submittal.

6. In addition to Status Reports (see Section I), the Grantee shall provide information requested by the CARB Project Liaison that is needed to assess progress in completing tasks and meeting the objectives of the project.

7. Any change in budget allocations, redefinition of deliverables, or extension of the project schedule must be requested in writing to the CARB Project Liaison and approved by CARB, in its sole discretion, and may require a grant amendment.

I. REPORTING

Status Reports

1. The Grantee will submit Status Reports at a minimum of three-month intervals. The Status Reports shall be provided in a format agreed upon between the CARB Project Liaison and the Grantee, meet the requirements of the Solicitation (Exhibit C), and include all information required in Section F.3.d.

2. Every Grant Disbursement Request Form (Form MSCD/ISB-90) shall be accompanied by a Status Report that documents the completion of a milestone(s) specified in Exhibit B, Attachment II.

3. If the project is behind schedule, the Status Reports must contain an explanation of reasons and a detailed explanation of how the Grantee plans to resume the schedule.

Final Report

4. When the project is complete, the Grantee shall submit a draft Final Report. The draft Final Report must be submitted to CARB in an appropriate format agreed upon between the CARB Project Liaison and the Grantee. Upon approval of the draft Final Report by the CARB Project Liaison, the Grantee shall provide a printed and electronic copy of the Final Report.

J. TERMINATION AND SUSPENSION OF PAYMENTS

1. CARB reserves the right to terminate this grant upon thirty days' written notice to the Grantee, if CARB determines that the project has not progressed satisfactorily during the previous three months and the Grantee and CARB have been unable to agree on modifications. In case of early termination, the Grantee will submit a Grant Disbursement Request Form, a Status Report covering activities up to, and including, the termination date. The Status Report must follow the requirements in Section I. Upon receipt of the Grant Disbursement Request Form and all Status Reports, a final payment will be made to the Grantee. This payment shall be for all CARB-approved, actually incurred costs that in the opinion of CARB are justified. However, the total amount paid shall not exceed the total grant amount.

2. CARB reserves the right to issue a grant suspension order in the event that a dispute should arise. The grant suspension order will be in effect until the dispute has been resolved or the grant has been terminated. If the Grantee chooses to continue work on the project after receiving a grant suspension order, the Grantee will not be reimbursed for any expenditure incurred during the suspension in the event CARB terminates the grant. If CARB rescinds the suspension order and does not terminate the grant, CARB will reimburse the Grantee for any expenses incurred during the suspension that are reimbursable in accordance with the terms of the grant.

K. CONTINGENCY PROVISION

1. In the event this grant is terminated for whatever reason, the CARB Executive Officer or designee reserves the right in his or her sole discretion to award a grant to the next highest scored applicant and if an agreement cannot be reached, to the next applicant(s) until an agreement is reached. If CARB is unable to award a grant under these circumstances, CARB may award a grant to other projects.

L. PROJECT RECORDS

Grantee Record

1. As further described below, project records include but are not limited to Grantee, financial, and other records. All project records must be retained for a period of three (3) years after final payment under this grant. All project records are subject to audit pursuant to Section M of this Grant Agreement. Upon completion of the third year of record retention, the Grantee shall submit all project records to CARB. Hardcopy of electronic records are suitable. Acceptable forms of electric media must be approved based on prior written concurrence from CARB.

2. The Grantee shall retain a file for the project containing but not limited to:

   a. Original executed copy of the Grant Agreement and Grant Agreement Amendments (if applicable);

   b. Copies of Grant Disbursement Request Forms;

   c. If applicable, documentation of earned interest generation and expenditure;

   d. All project Status Reports;

   e. Invoices from project participants for reimbursable items; and

   f. All other information that documents all aspects of the project.

3. Other records include all deliverables required in Exhibit B, Attachment III, of this Grant Agreement.

Financial Record

4. Without limitation of the requirement to maintain project accounts in accordance with generally accepted accounting principles, the Grantee must:

   a. Establish an official file for the project, which shall adequately document all significant actions relative to the project;

   b. Establish separate accounts, which will adequately and accurately depict all amounts received and expended on the project;

   c. Establish separate accounts, which will adequately and accurately depict all income received which is attributable to the project, including cash and in-kind match; and

   d. Establish an accounting system, which will adequately depict final total costs of the project, including both direct and indirect costs.

M. GENERAL PROVISIONS

1. **Amendment:** No amendment or variation of the terms of this Grant Agreement shall be valid unless made in writing, signed by the parties and approved as required. No oral understanding or agreement not incorporated in the Grant Agreement is binding on any of the parties.

2. **Assignment:** This grant is not assignable by the Grantee, either in whole or in part, without the consent of CARB in the form of a formal written amendment.

3. **Audit:** Grantee agrees that CARB, the Department of General Services, Department of Finance, the Bureau of State Audits, or their designated representative shall have the right to review and to copy any records and supporting documentation pertaining to the performance of this grant and all State funds received. Grantee agrees to maintain such records for possible audit for a minimum of three (3) years after the term of this grant is completed, unless a longer period of records retention is stipulated. Grantee agrees to allow the auditor(s) access to such records during normal business hours and to allow interviews of any employees who might reasonably have information related to such records. Further, Grantee agrees to include similar right of the State to audit records and interview staff in any subgrant or subcontract related to performance of this Grant Agreement.

4. **Availability of funds:** CARB's obligations under this Grant Agreement are contingent upon the availability of funds. In the event funds are not available, the State shall have no liability to pay any funds whatsoever to the Grantee or to furnish any other considerations under this Grant Agreement.

5. **Compliance with law, regulations, etc.:** The Grantee agrees that it will, at all times, comply with and require its contractors and subcontractors to comply with all applicable federal and State laws, rules, guidelines, regulations, and requirements.

6. **Conflict of interest:** The Grantee certifies that it is in compliance with applicable State and/or federal conflict of interest laws.

7. **Disputes:** The Grantee shall continue with the responsibilities under this Grant Agreement during any dispute. Grantee staff or management may work in good faith with CARB staff or management to resolve any disagreements or conflicts arising from implementation of this Grant Agreement. However, any disagreements that cannot be resolved at the management level within 30 days of when the issue is first raised with CARB staff shall be subject to resolution by the CARB Executive Officer, or his designated representative. Nothing contained in this paragraph is intended to limit any rights or remedies that the parties may have under law.

8. **Environmental justice:** In the performance of this Grant Agreement, the Grantee shall conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures the fair treatment of people of all races, cultures, and income levels, including minority populations and low-income population of the State.

9. **Fiscal management systems and accounting standards:** The Grantee agrees that, at a minimum, its fiscal control and accounting procedures will be sufficient to permit tracing of grant funds to a level of expenditure adequate to establish that such funds have not been used in violation of State law or this

Grant Agreement. Unless otherwise prohibited by State or local law, the Grantee further agrees that it will maintain separate project accounts in accordance with generally accepted accounting principles.

10. **Force majeure:** Neither CARB nor the Grantee shall be liable for or deemed to be in default for any delay or failure in performance under this Grant Agreement or interruption of services resulting, directly or indirectly, from acts of God, enemy or hostile governmental action, civil commotion, strikes, lockouts, labor disputes, fire or other casualty, etc.

11. **Governing law and venue:** This grant is governed by and shall be interpreted in accordance with the laws of the State of California, CARB and the Grantee hereby agree that any action arising out of this Grant Agreement shall be filed and maintained in the Superior Court in and for the County of Sacramento, California, or in the United States District Court in and for the Eastern District of California. The Grantee hereby waives any existing sovereign immunity for the purposes of this Grant Agreement.

12. **Indemnification:** The Grantee agrees to indemnify, defend and hold harmless the State and the Board and its officers, employees, agents, representatives, and successors-in-interest against any and all liability, loss, and expense, including reasonable attorneys' fees, from any and all claims for injury or damages arising out of the performance by the Grantee, and out of the operation of equipment that is purchased with funds from this Grant Award.

13. **Grantee's responsibility for work:** The Grantee shall be responsible for work and for persons or entities engaged in work, including, but not limited to, contractors, subcontractors, suppliers, and providers of services. The Grantee shall be responsible for any and all disputes arising out of its contract for work on the project, including but not limited to payment disputes with contractors, subcontractors, and providers of services. The State will not mediate disputes between the Grantee and any other entity concerning responsibility for performance of work.

14. **Independent contractor:** The Grantee, and its agents and employees, if any, in their performance of this Grant Agreement, shall act in an independent capacity and not as officers, employees or agents of CARB.

15. **Nondiscrimination**: During the performance of this Grant Agreement, the Grantee and its third party entities shall not unlawfully discriminate, harass, or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, physical disability (including HIV and AIDS), mental disability, medical condition (e.g., cancer), age (over 40), marital status, and denial of family care leave. The Grantee and its third party entities shall insure that the evaluation and treatment of their employees and applicants for employment are free from such discrimination and

harassment. The Grantee and its third party entities shall comply with the provisions of the Fair Employment and Housing Act (Gov. Code §12990 (a-f) et seq.) and the applicable regulations promulgated thereunder (California Code of Regulations, Title 2, Section 7285 et seq.). The applicable regulations of the Fair Employment and Housing Commission implementing Government Code Section 12990 (a-f), set forth in Chapter 5 of Division 4 of Title 2 of the California Code of Regulations, are incorporated into this Agreement by reference and made a part hereof as if set forth in full. The Grantee and its third party entities shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement.

The Grantee shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform work under this Grant Agreement

16. **No third party rights:** The parties to this Grant Agreement do not create rights in, or grant remedies to, any third party as a beneficiary of this Grant Agreement, or of any duty, covenant, obligation or undertaking establish herein.

17. **Ownership:** All information or data received or generated by the Grantee under this agreement shall become the property of CARB. No information or data received or generated under this agreement shall be released without CARB's approval. Notwithstanding the above, in the event Grantee is required by deposition, interrogatory, subpoena, or request for documents under the Public Records Act to disclose information or data received or generated under this agreement, Grantee shall provide CARB a prompt written notice prior to disclosure.

18. **Prevailing wages and labor compliance:** If applicable, the Grantee agrees to be bound by all the provisions of State Labor Code Section 1771 regarding prevailing wages. If applicable, the Grantee shall monitor all agreements subject to reimbursement from this Grant Agreement to ensure that the prevailing wage provisions of State Labor Code Section 1771 are being met.

19. **Professionals:** For projects involving installation or construction services, the Grantee agrees that only licensed professionals will be used to perform services under this Grant Agreement where such services are called for and licensed professionals are required for those services under State law.

20. **Severability:** If a court of competent jurisdiction holds any provision of this Grant Agreement to be illegal, unenforceable or invalid in whole or in part for any reason, the validity and enforceability of the remaining provisions, or portions of those provisions, will not be affected.

21. **Termination:** CARB may terminate this Grant Agreement by written notice at any time prior to completion of projects funded by this Grant Agreement, upon violation by the Grantee of any material provision after such violation has been

called to the attention of the Grantee and after failure of the Grantee to bring itself into compliance with the provisions of this Grant Agreement.

22. **Timeliness:** Time is of the essence in this Grant Agreement. Grantee shall proceed with and complete the project in an expeditious manner.

23. **Waiver of rights:** Any waiver of rights with respect to a default or other matter arising under the Grant Agreement at any time by either party shall not be considered a waiver of rights with respect to any other default or matter. Any rights and remedies of the State provided for in this Grant Agreement are in addition to any other rights and remedies provided by law.

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Attachment I – Budget Summary
Attachment II – Project Milestones and Disbursement Schedule
Attachment III – Project Schedule
Attachment IV – Key Project Personnel

Budget Summary

Grantee: The Port Of Los Angeles Harbor Department Grant No.: G16-DEMO-08

Project: Zero-Emission Track-Miles Locomotive Demonstration

Total Costs & Funding

Costs	Grant	Applicant Match Funding		Total
	Cash	Cash	In-Kind	
Demonstration Technology Funds	$2,768,830	$892,371	$171,949	$3,833,150
Administrative Funds[1]	$ 0	$ 0	$ 0	$ 0
Total	$2,768,830	$892,371	$171,949	$3,833,150

[1] Administrative funds may not exceed 5% of CARB-awarded funds and may only be used for administrative purposes.

Disbursement of Funds:

Demonstration Technology Funding
The Grantee shall receive funds in accordance with the Fiscal Year 2016-17 Low Carbon Transportation GGRF Investments: Off-Road Advanced Technology Demonstration Project.

Project Administration
The Grantee shall receive project administration funding in accordance with the Fiscal Year 2016-17 Low Carbon Transportation GGRF Investments: Off-Road Advanced Technology Demonstration Project.

EXHIBIT B, Attachment II

Project Milestones and Disbursement Schedule

Grantee: The Port Of Los Angeles Harbor Department Grant No.: G16-DEMO-08

Project: Zero-Emission Track-Miles Locomotive Demonstration

Milestone	Task Description	Task Deliverables[1]	Project Funding	
			Project Funds	Admin Funds
Task 1.0 Administrative and Project Management				
1.1	Kick-off meeting		$0	$0
1.2	Quarterly project update meetings and reports	Quarterly project Status Reports, quarterly meeting materials	$0	$0
1.3	Final Report	Final Report	$0	$0
NOTE: POLA Staff time is being contributed as needed to successfully implement this project, but not an official match				
Task 2.0 Design and Construction of Charging Infrastructure				
2.1	Permitting and administration for task 2.0	Infrastructure drawings and test plan. Proof of infrastructure approval.	$0	$0
2.2	Charging station installation and power supply connection	Proof of operational chargers	$0	$0
2.3	Testing and commissioning	Final commissioning report	$0	$0
Task 3.0 Demonstration and Locomotive Design and Build				
3.1	Locomotive design and build, purchase parts	Drive and system component test plan	$0	$0
3.1a	Charge input rectifier	Charge input rectifier invoice and proof of payment	$0	$0

Milestone	Task Description	Task Deliverables[1]	Project Funding	
			Project Funds	Admin Funds
3.1b	Battery Pod Design and Testing	Battery pod test plan and results, UN38.3 certification forms	$105,000	$0
3.1c	Battery Pods Purchase	Battery Pod Invoice and Proof of Payment, Photos	$0	$0
3.1c (i)	Recurring Milestone: Battery Pod Purchase (Cost $201,309 per Battery Pod, ten total)	Battery Pod Invoice and Proof of Payment, Photos	$2,013,090	$0
3.1c (ii)	Battery Pod Purchase (Partially Donated)	Partially Donated Battery Pod Invoice and Proof of Payment, Photos	$41,360	$0
3.1d	High- Voltage Control Computer System Development	Documented proof of a completed High Voltage Control System.	$171,700	$0
3.1d (i)	500 Amp Dual Chopper Modules (Individual, 6 total)	Dual Chopper Module Invoice and Proof of Payment	$21,400	$0
3.1d (ii)	500 Amp Inductor Module (Individual, 11 total)	Inductor Module Invoice and Proof of Payment	$6,470	$0
3.1 d (iii)	High-Voltage Control Computer System Design and Commissioning	Component Invoices/Proof of Payment, Computer Remote Diagnostic Test Report, System Schematics, and Monitoring Data.	$63,810	$0
3.1e	Locomotive Control Computer Upgrades	Component Invoices/Proof of Payment, Diagnostic Test Report	$56,000	$0

Milestone	Task Description	Task Deliverables[1]	Project Funding	
			Project Funds	Admin Funds
3.1f	Cooling Systems	Component Invoices/Proof of Payment, Cooling System Operating and Maintenance Manual, Electrical Diagram, Photos	$40,000	$0
3.1g	Battery Mounting Engineering/Testing	Battery Mounting Specifications, 3-d Models, Component invoices/proof of payment, and final test report.	$250,000	$0
3.2	Demonstration Locomotive Commissioning and Deployment	A copy of all training materials and roster of participating staff, copy of infrastructure testing results.	$0	$0
Task 4.0 Demonstration				
4.1	Demonstration	Status Reports on equipment in-servicing and operation	$0	$0
Task 5.0 Data Collection and Analysis				
5.1	Data Collection	Data collection plan prior to beginning of demonstration, Collected data provided in Status Reports.	$0	$0
5.2	PEMS Analysis	Collected PEMS data to be provided in Status Reports.	$0	$0
5.3	Data evaluation	All collected data.	$0	$0
Subtotal of Project Funds and Administrative Funds			**$ 2,768,830**	**$0**
Grant Total Funding Amount			**$ 2,768,830**	

[1] More detailed deliverable descriptions can be found in Exhibit B, Attachment III, Project Schedule.

EXHIBIT B, Attachment III

Project Schedule

Grantee: The Port Of Los Angeles Harbor Department Grant No.: G16-DEMO-08
Project: Zero-Emission Track-Miles Locomotive Demonstration

Detailed Scope of Work and Schedule

Work Task	Estimated Start Date	Estimated Completion Date
Task 1: Administration & Project Management		
Task 1.1 Kick-off Meeting – Zero-Emission Track-Miles Locomotive Demonstration Project Team The project team will meet with CARB and third-party data analysis team (TetraTech/CE-CERT) to discuss the workplan, task performance details, schedule, and the approach for issue/problem resolution.	May 2018	May 2018
1.2 Quarterly Project Update Meetings & Reports – POLA The POLA will coordinate quarterly project update meetings that will be disbursement requests, and held via WebEx or teleconference to discuss progress. The meetings will follow a defined agenda that will cover project status update, difficulties encountered, upcoming deliverables, pending schedule of the next update meeting. The POLA will also create quarterly Status Reports, quarterly agendas, and disbursement requests; which will be provided to CARB and follow the guidelines outlined in Exhibit A, Grant Provisions.	May 2018	Aug 30 2018
1.3 Final Report – POLA At the completion of the project, the POLA will submit a draft Final Report to CARB by February 14, 2020 that describes the project goals and objectives, methods, results of the demonstration, future application of the technologies, and commercialization prospects. The Final Report will be finalized and submitted to CARB by March 30, 2020. Deliverables: Draft Final Report on Feb 14, 2020 and Final Report on or before March 30, 2020.	Dec 2019	Draft Final Feb 14, 2020 Final Mar 30, 2020

Work Task	Estimated Start Date	Estimated Completion Date
Task 2: Design and Construction of Charging Infrastructure		
2.1 – Permitting and Administration for Task 2.0 The POLA will acquire any permits necessary for infrastructure construction at the PHL Facility. The POLA will also develop as-built drawings and conduct testing. Additionally, as-needed administrative services for any tasks in Task 2.0, including charging infrastructure testing and commissioning and producing associated reports. Deliverable: As-built drawings, infrastructure test plan, and test results. Documented proof of infrastructure approval from municipal oversight agency.	June 2018	July 2018
2.2 – Charging Station Installation and Power Supply Connection The POLA will design and build the charging infrastructure at the PHL facility. A preliminary assessment of the existing electric infrastructure determined that the substation on the terminal has a dedicated transformer that is more than sufficient for the demonstration project's proposed load. The POLA will manage the installation and associated system integration. POLA engineering estimates approximately three months for installation once design is complete. The required charging equipment will be sourced from Northwest Rail Electric and will connect to standardized electrical infrastructure. The charging system consists of a base charger cabinet, support equipment, and cable to connect to the on-board charger unit. Deliverables: Proof of operational chargers and final approval from municipal power agency	June 2018	July 2018
2.3 – Testing and Commissioning The POLA will provide the desired sequences of operation for the electrical monitoring and controls system. Once all of the equipment is operational, the POLA will lead the commissioning effort of the overall system being installed under this project. This will include technical advice from Los Angeles Department of Water and Power including operation for peak shaving and islanded operation. The commissioning procedures and results will be documented in a final commissioning report to be included in the reports to be submitted to CARB. Deliverable: Final commissioning report	Dec 2018	Dec 2018

Work Task	Estimated Start Date	Estimated Completion Date
Task 3: Demonstration Locomotive Design and Build		
3.1 – Locomotive Design and Build, Purchase Parts VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including will ordering all the components in Tasks 3.1a through 3.1g. VeRail will test all drive system components on the locomotive and then test the entire system to ensure it functions properly. They then undertake a series of drive tests to validate the basic functionality and safety of the system. Deliverable: Drive and system component test plan	June 2018	Nov 2018
3.1a – Ordering Charge Input Rectifier VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including ordering charge input rectifier sourced from American Traction Systems (ATS) Deliverables: Charge Input Rectifier Invoice and Proof of Payment	June 2018	Nov 2018
3.1b – Battery Pod Design and Testing VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including ordering all the battery pod design and testing (sourced from Voltabox) Deliverables: Battery Pod test plan, results of testing, and UN38.3 Certification Forms.	June 2018	Nov 2018
3.1c – Purchase of 11 Battery Pods VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including purchasing 11 battery pods – one partially donated (sourced from Voltabox).	June 2018	Nov 2018
3.1c (i) – Purchase of individual battery pods VeRail will purchase a total of ten (10) individual battery pods from Voltabox. Deliverables: Battery pod invoice and proof of payment. Additionally, batteries will be photographed prior to installation.	June 2018	Nov 2018

Work Task	Estimated Start Date	Estimated Completion Date
3.1c (ii) – Purchase of discounted battery pod VeRail will purchase one (1) partially discounted battery pod from Voltabox. Deliverables: Partially donated battery pod invoice and proof of payment. Additionally, the battery will be marked with an identifying feature that will show it is separate from the purchased batteries under the agreement. The battery and its identifying feature will be photographed.	June 2018	Nov 2018
3.1d – Development of a High Voltage Control System VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including development of a high voltage control system and the purchase of six 500 amp dual chopper modules and eleven 500 amp inductor modules (sourced from ATS). Deliverable: Documented proof of a completed high voltage control system.	June 2018	Nov 2018
3.1d (i) – Purchase individual 500 Amp Dual Chopper Modules VeRail will purchase individual 500 amp dual chopper modules from ATS. Deliverables: Dual chopper module invoice and proof of payment.	June 2018	Nov 2018
3.1d (ii) – Purchase individual 500 Amp Inductor Modules VeRail will purchase individual 500 Amp Inductor Modules from ATS Deliverables: Inductor Module Invoice and proof of payment.	June 2018	Nov 2018
3.1d (iii) – Design and integrate the High-Voltage Control Computer System VeRail will complete the design and integrate the High-Voltage Control Computer System into the demonstration locomotive. Deliverables: Component invoices/proof of payment, computer remote diagnostic test report, system schematics, and monitoring data.	June 2018	Nov 2018

Work Task	Estimated Start Date	Estimated Completion Date
3.1e – Locomotive Control System Computer Upgrades VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including locomotive control system computer upgrades (sourced from TMV) Deliverables: Component invoices and proof of payment, computer remote diagnostic test report	June 2018	Nov 2018
3.1f – Cooling Systems VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including cooling systems. Deliverables: Component Invoices/Proof of Payment, Cooling System Operating and Maintenance Manual, and Electrical diagram. The cooling system will be photographed upon arrival and again after installation.	June 2018	Nov 2018
3.1g – Battery Mounting Engineering/Testing VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including battery mounting engineering and testing Deliverables: Battery Mounting Specifications, 3-d Models, Component invoices/proof of payment, and final test report.	June 2018	Nov 2018
3.2 – Demonstration Locomotive Commissioning/Deployment Upon delivery and deployment of the locomotive at the PHL facility, charging infrastructure will be tested, and training of PHL operational and maintenance crews will begin. VeRail will provide on-site and classroom training up to 40 hours for all personnel involved with operation of the locomotive, as well as a printed and digital set of operator training manuals. Deliverables: A copy of all training materials and roster of participating staff, certification of training completion, a copy of infrastructure testing results, and a copy of the commissioning report.	Dec 2018	Jan 2019

Work Task	Estimated Start Date	Estimated Completion Date
Task 4: Demonstration The demonstration phase will show how zero-emission locomotive can operate conducting daily PHL switching duties. Following deployment of equipment and training of staff, a nine-month demonstration will begin.		
4.1 – Demonstration PHL, VeRail The demonstration phase will show how zero-emission locomotive can operate conducting daily PHL switching duties. Following successful commissioning and deployment of equipment and training of staff on operation and maintenance, a nine-month demonstration will begin. It is anticipated that equipment will be capable of operating continuously for an 8-hour shift. Deliverables: Status Reports on equipment in-servicing and operation	Jan 2019	Sept 2019
Task 5: Data Collection and Analysis Third Party Data Contractor Tetra Tech Analysis of data collected from baseline and battery locomotives as well as general feedback on operator acceptance.	Jan 2019	Sept 2019
5.1 – Field Data Collection Locomotives will be equipped with an event recorder that also tracks Global Positioning System (GPS) data. This device is provided by PHL and VeRail, who will ensure that the data are available. The event recorder, including GPS, provides the ability to monitor all performance parameters in real-time from a cloud-based server, including fuel efficiency (miles/kWh), battery state-of-charge (SOC), mileage/odometer readings, runtime, idle time, kWh of operation (including detailed amperage and voltage data), battery temperature, speed, and charging current/voltage. . All real-time and historical data will be available in chart form and as a download for analysis by the POLA, CARB, and the third party data analysis firm (Tetra Tech/CE-CERT). Deliverable: Data collection plan to CARB prior to beginning of demonstration. Collected data provided in Status Reports.	Jan 2019	Sept 2019

Work Task	Estimated Start Date	Estimated Completion Date
5.2 – Portable Emissions Measurement Systems (PEMS) Testing CE-CERT will provide one to two weeks of PEMS testing, including travel to the site, installation and equipment preparation on-site, and actual testing. PEMS testing will incorporate typical pollutants, including Total Hydrocarbons (THC), Carbon monoxide, Nitrogen oxide (NOx), Particulate Matter (PM), and Carbon dioxide (CO2). Since Methane (CH4) is not typically incorporated into PEMS system, CH4 emissions will be determined as a percentage of the THC emissions measurements. This can be done based on factors provided in the Code of Federal Regulations (CFR) for determining methane emissions when a dual Flame Ionization Detector is not available, or based on typical percentages of CH4 found in diesel or other exhaust. A PEMS for the measurement of PM can also be included in the testing. It is expected that the natural gas and diesel locomotives will take one week each to test, so depending on whether one or both locomotives will need to be tested, this task will last one to two weeks. Note that the number of hours/days on each piece of equipment will depend on the number of hours of testing required during each test day, and the level of assistance that is available on-site for the installation of the equipment. Deliverable: Collected PEMS data to be provided in Status Reports	Jan 2019	Sept 2019

Work Task	Estimated Start Date	Estimated Completion Date
5.3 – Data Analysis It is expected that all data collection for the analysis will be provided electronically via a remote data link by PHL and VeRail. For the potential development of a hybrid ultra-low NOx natural gas and battery electric switcher locomotive, Tetra Tech's team will process and analyze the collected data to determine activity patterns including hours of operation, days of operation per year, miles traveled per day using GPS data (and associated odometer reading per day and per shift if shift times are provided), average value and distribution of speed and acceleration based on GPS data, and idling time. GPS data can be analyzed to determine the number of trips between specific locations that are related to loading and unloading cargo, and refueling. This information will be used to assess the performance and duty cycle of the different equipment between the advanced technology equipment and the baseline equipment as a function of time, including the number of trips, and typical loading times. These parameters will be evaluated for the 9 month demonstration period. These parameters can also be evaluated for a normal vs. peak period (i.e., holiday, overtime, double shift) and for specific periods of interest (e.g., high and low temperature operation, during the first and last hour of each shift, etc.). Tetra Tech/CE-CERT will analyze the performance of the locomotive in terms of the state-of-charge (SOC) throughout the work shift (minute-by-minute), fuel/energy consumption rate per work completed/distance driven, and fuel/energy consumption while idling. It is assumed for this project that the SOC, energy consumption, and other battery performance parameters can be obtained directly from the locomotive control computer as part of the normal data logging connection. It is anticipated that perhaps two weeks of engineering time will be needed to develop the appropriate configuration files to gather this information for the different vehicles, and this is incorporated in the budget. Battery degradation in terms of battery charge/power output and the SOC that can be obtained on a full charge will also be determined over the length of the project. Deliverables: All collected data and Data Analysis Report	Sept 2019	Dec 2019

*More detailed work task information can be found in Exhibit D, Grantee Application Package

EXHIBIT B, Attachment IV

Key Project Personnel

Grantee: The Port Of Los Angeles Harbor Department   Grant No.: G16-DEMO-08

Project: Zero-Emission Track-Miles Locomotive Demonstration

*More detailed key project personnel information can be found in Exhibit D, Grantee Application Package

Name	Position	Duties
Jacob Goldberg	Project Manager, POLA	Project Management and Oversight.
Christopher Cannon	Chief Sustainability Officer, POLA	Project Director – Provides overall leadership and executive oversight for the project.
Tim DeMoss	Marine Environmental Supervisor, POLA	Lead staff for technology demonstration – Oversees and coordinates technology demonstration partners' participation in the project.
Tom Mack	President/CTO, VeRail	Provide locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.
Otis Cliatt	President, Pacific Harbor Line	Provide testing platform for Zero-Emissions Track-Miles Locomotive Demonstration project.
Michael Unkelbach	Vice President Research and Development, Voltabox	Provide battery and technical support for locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.
Dr. Anthony (Tony) Davis	Vice President, American Traction Systems	Provide battery control system technical support for locomotive for Zero-EmissionsTrack-Miles Locomotive Demonstration

Name	Position	Duties
Eddy Huang, PhD	Director of the Air Quality/Clean Transportation, Tetra Tech	Data analysis management
Matt Miyasato, PhD	Deputy Executive Officer for Science & Technology Advancement, South Coast AQMD	Technical Advisor – Development and commercialization of clean air technologies
Tomy Giang,	Electrical Engineer, EV Power Distribution and Service Planning, LA Dept. . of Water and Power	Technical Advisor – Provides utility advice and energy optimization scenarios
Jess Marquez	Executive Director, Coalition for A Safe Environment	Community Advisor

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EXHIBIT C, SOLICITATION
GRANT NUMBER: G16-DEMO-08

2016-2017 GRANT SOLICITATION

Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program

Off-Road Advanced Technology Demonstration Projects

Mobile Source Control Division
California Air Resources Board
June 9, 2017

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

California Environmental Protection Agency

Air Resources Board

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EXHIBIT D, GRANTEE APPLICATION
GRANT NUMBER: G16-DEMO-08

GRANTEE APPLICATION PACKAGE

2016-2017 GRANT SOLICITATION

Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program

Off-Road Advanced Technology Demonstration Projects

Mobile Source Control Division
California Air Resources Board
June 9, 2017

California Environmental Protection Agency

Air Resources Board

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California Air Resources Board
Low Carbon Transportation and Fuels Investments and
the Air Quality Improvement Program

Off-Road Advanced Technology Demonstration Projects

June 9, 2017

Table of Contents

I. SUMMARY

The California Air Resources Board (CARB or Board) is soliciting one or more Grantees to implement and administer the Off-Road Advanced Technology Demonstration Project under the Air Quality Improvement Program (AQIP) and Low Carbon Transportation Greenhouse Gas Reduction Fund (GGRF) Investments, as identified in the Fiscal Year (FY) 2016-17 Funding Plan approved by the Board in June 2016[1]. The Board initially approved a $59 million allocation for advanced technology demonstration projects during the preliminary approval of the FY 2016-17 Funding Plan, however, the state legislature appropriated less funding than anticipated. Therefore, the Board reconvened in October 2016 to revise the funding allocation for heavy-duty projects and approved $34 million for demonstration projects. As part of this allocation, this Solicitation for off-road advanced technology demonstration projects anticipates up to $17 million will be available and several independent grantees may be selected. A separate On-Road Advanced Technology Demonstration Project Solicitation was released on May 19, 2017 and is part of the total allocation for demonstration projects.

This Solicitation intends to accelerate into the California marketplace the introduction of advanced emission reducing technologies on the cusp of commercialization. The technologies demonstrated must have the potential for widespread commercialization and significant transformation of the industry while achieving greenhouse gas (GHG), criteria pollutant, and toxic emission reductions benefitting disadvantaged communities.[2] For heavy-duty off-road equipment (including vehicles) used in freight (i.e., cargo handling, locomotive, and ground support) and non-freight (i.e., agriculture, construction, and passenger transport) operations, these advanced technology demonstration projects will build upon advances from prior demonstration projects by expanding the type and numbers of zero-emission and near zero-emission equipment used in off-road operations and facilitating the opportunity for technology transfer from other applications such as on-road. These project(s) will reduce GHG emissions and provide economic, environmental, and public health co-benefits to disadvantaged communities, while synergistically demonstrating the practicality and economic viability of widespread adoption of advanced off-road technologies. All work must be completed by March 30, 2020. Specific tasks are outlined within this Solicitation. Applications are due to CARB no later than **5:00 p.m., September 7, 2017.**

This Solicitation is issued under the Assembly Bill 118 (AB 118) AQIP Advanced Technology Demonstration Projects and the Low Carbon Transportation Investments, with all project funds coming from the Cap-and-Trade auction proceeds deposited into the Greenhouse Gas Reduction Fund as part of the California Climate Investments (CCI). The project is intended to fund technologies on the cusp of

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[1] The approved Fiscal Year 2016-17 Funding Plan for AQIP and Low Carbon Transportation GGRF Investments is available at http://www.arb.ca.gov/msprog/aqip/fundplan/fundplan.htm.

[2] The Disadvantaged Communities, as identified by the California Environmental Protection Agency, are available at www.calepa.ca.gov/EnvJustice/GHGInvest/.

commercialization that further the purposes of AB 32 (Nunez, Chapter 488, Statues of 2006) and the more recent SB 32, which codified a 2030 GHG emissions reduction target of 40 percent below 1990 levels.[3] This competitive Solicitation is open to local air districts or other California-based public agencies, as well as California-based non-profit organizations that demonstrate the requisite administrative and technical expertise.

II. BACKGROUND

In 2007, the *California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007* (AB 118, Statutes of 2007, Chapter 750) was signed into law. AB 118 created AQIP, a voluntary incentive program administered by CARB, to fund clean vehicle and equipment projects, air quality research, and workforce training.

As required in Health and Safety Code (HSC) Section 44274(a), the Board adopted regulatory guidelines in 2009 for AQIP. The Guidelines for the AB 118 Air Quality Improvement Program (Guidelines)[4] define the overall administrative requirements, policies, and procedures for program implementation based on the framework established in statute. Central to the Guidelines is the requirement for a Board-approved annual funding plan developed with public input. The funding plan is each year's blueprint for expending AQIP funds appropriated to CARB in the annual State Budget. The funding plan focuses AQIP on supporting development and deployment of the advanced technologies needed to meet California's longer-term, post-2020 air quality goals.

In 2012, the Legislature passed, and Governor Brown signed into law, three bills – AB 1532 (Pérez, Chapter 807), SB 535 (De León, Chapter 830), and SB 1018 (Budget and Fiscal Review Committee, Chapter 39) that established GGRF to receive Cap-and-Trade auction proceeds and to provide the framework for how the auction proceeds will be administered in furtherance of the purposes of AB 32, including supporting long-term, transformative efforts to improve public health and develop a clean energy economy. The suite of implementing legislation offers strong direction for investing a portion of the auction proceeds to benefit disadvantaged communities, including specific allocation requirements in SB 535.

In 2014, the Legislature appropriated nearly $200 million dollars in GGRF monies to establish a Low Carbon Transportation GGRF program that CARB is implementing in coordination with the AQIP AB 118 programs. Projects funded by the Low Carbon Transportation GGRF program must reduce GHG emissions and further the purposes of AB 32, with a strong emphasis on benefiting disadvantaged communities.

[3] SB 32 can be found at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32
[4] The Guidelines for the AB 118 Air Quality Improvement Program are available at www.arb.ca.gov/msprog/aqip/aqip.htm.

In order to identify the priority investments that facilitate GHG emission reductions, the legislature directed the development of the Cap-and-Trade Auction Proceeds Investment Plan (Investment Plan).[5] The 3-year Investment Plan, which was released in May 2013, calls for projects that support the large-scale deployment of alternative technologies, such as zero- and near zero-emission vehicles, to help achieve the State's near-term and longer-term GHG emission reduction goals. In addition, SB 535 directs at least 25 percent of funding from GGRF to be allocated toward projects that benefit disadvantaged communities and at least 10 percent of funding from GGRF must be allocated toward projects located within disadvantaged communities, as identified by the California Environmental Protection Agency (Cal/EPA).[6]

Because the Governor's goals for the investment of GGRF monies are consistent with the established objectives of AQIP, and because of the past success of the AQIP structure, staff has combined the two funding sources (AQIP and Low Carbon Transportation GGRF Investments) into one funding plan. The Funding Plan for AQIP and Low Carbon Transportation GGRF Investments is designed to support development and commercialization of advanced technologies necessary to meet California's long-term air quality and climate goals.

This Solicitation is also supportive of Executive Order B-32-15, which directed the development of the California Sustainable Freight Action Plan.[7] This action plan was released July 29, 2016, and includes three main targets:

- System Efficiency Target – Improve freight system efficiency 25 percent by increasing the value of goods and services produced from the freight sector, relative to the amount of carbon that it produces by 2030.

- Zero-Emission Technology Target – Deploy over 100,000 freight vehicles and equipment capable of zero-emission operation and maximize near zero-emission freight vehicles and equipment powered by renewable energy by 2030.

- Competitiveness and Economic Target – Establish a target(s) for increased State competitiveness and future economic growth within the freight and goods movement industry.

In June 2016, the Board approved the Fiscal Year 2016-17 Funding Plan, which described how CARB would spend $500 million in proposed Low Carbon Transportation and Fuels funding from GGRF and $23.6 million from AQIP. In August 2016, the Legislature approved Assembly Bill 1613 (Committee on Budget, Chapter 370), which appropriated $363 million to CARB for Low Carbon Transportation projects. In October

[5] The Cap-and-Trade Auction Proceeds Investment Plan is available at http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/auctionproceeds.htm.
[6] The identified Disadvantaged Communities census tracts are available at http://www.calepa.ca.gov/EnvJustice/GHGInvest/.
[7] CARB et al. California Sustainable Freight Action Plan; July 2016; http://www.casustainablefreight.org/theplan.html

2016, the Board approved modifications to the FY 2016-17 Funding Plan to reflect the reduced appropriation and instructed all demonstration funds to primarily focus on projects that support CARB's sustainable freight action plan and benefit disadvantaged communities.

The Funding Plan identifies projects that both provide immediate emission reductions from the vehicles and/or equipment directly funded and, more importantly, set the stage for greater, indirect reductions in the future by accelerating large-scale market penetration and technology transfer to other sectors. Funding is provided for projects that support evolution through three phases of technology advancement: demonstration, commercialization, and transition to widespread deployment. For the demonstration phase, the FY 2016-17 Funding Plan allocated up to $34 million for the Advanced Technology Demonstration Projects with the intent of incentivizing the deployment of early commercial heavy-duty technologies. These Advanced Technology Demonstration Projects will be split into two separate solicitations, one for heavy-duty on-road vehicles and one for off-road equipment.

III. NEED FOR EMISSION REDUCTIONS FROM OFF-ROAD EQUIPMENT

Heavy-duty off-road equipment is a significant source of GHG, diesel particulate matter (PM), and oxides of nitrogen (NOx) emissions. PM and NOx, a precursor to ozone and secondary PM, are of particular interest throughout California, and heavy-duty off-road mobile equipment is a large contributor to these emissions statewide.[8] Their emissions result in increased health risks and mortality rates, as well as contribute to the challenge of meeting federal clean air standards. In addition, as with other types of pollution, disadvantaged communities are disproportionately affected by such emissions and have vulnerable populations. Heavy-duty off-road equipment play a major role in freight transport and is commonly used in freight support facilities such as distribution centers, warehouses, ports, and intermodal yards. Off-road equipment operating at freight facilities, such as forklifts, yard tractors, top handlers, trains, and marine vessels, handle cargo both off the roads and within the facility. Reducing emissions from these off-road pieces of equipment is not only necessary to meet federally imposed clean air standards, but also to reduce adverse health effects from their emissions, especially in disadvantaged communities.

While recent regulations aim to reduce the emissions impact from off-road equipment, the continued development and demonstration of advanced technologies are necessary to reach California's long-term GHG emission reduction goals, protect public health, and reach attainment with increasingly more stringent federal air quality standards. Projects selected under this Solicitation to demonstrate advanced technologies should be able to provide a significant reduction in GHG emissions and improve air quality for many

[8] The distribution of PM and NOx emissions from mobile source on-road and off-road applications (including agriculture, trains, and marine sources) are available at http://www.arb.ca.gov/regact/2014/truckbus14/tb14isor.pdf.

affected areas within the state when the technology is fully integrated into the marketplace.

IV. CURRENT TECHNOLOGY

There are a variety of advanced emission reducing technologies applicable to heavy-duty off-road equipment that meet the objectives of this Solicitation, ranging from those currently commercially available and have the potential to be expanded into new applications to those that have surpassed the research and development phase, but have not yet been introduced into the marketplace. As discussed below, there are significant opportunities to showcase the commercial viability and suitability of such technologies in off-road equipment.

A. Cargo Handling Equipment

Cargo handling equipment has already seen a strong push toward zero-emission technology driven both by economic and regulatory[9] goals. For example, there has been appreciable interest in electric yard trucks in freight operations, and a number of electric yard truck demonstrations have already been funded through programs implemented by CARB and/or other agencies. However, there has been much less activity in higher tonnage equipment operating at ports and intermodal rail yards, such as reach stackers, top handlers, and high lift-capacity forklifts powered by diesel, for which there is immense potential to significantly reduce GHG and criteria pollutant emissions with zero-emission technologies.

There are also opportunities to expand the use of technology that has already achieved market success in one application to other, more-demanding applications. A specific example of this is the battery-electric technology used in lift trucks. Battery-electric lift trucks with a 6,000-pound lift capacity can commonly be found in warehouse and distribution center environments. However, commercially available electric lift trucks are currently limited to about a 20,000-pound lift capacity.[10] Expanding battery-electric technology to larger lift-capacity forklifts (up to 40,000-pounds) traditionally powered by diesel fuel is a promising next step, and Low Carbon Transportation Investments can be used to help spur innovation and further reduce emissions locally and regionally.

B. Advanced Port Equipment

Cargo handling equipment is an important category to transition to zero-emission, but another technology category that has great potential to reduce GHG emissions and criteria pollutants is equipment that can increase operational efficiencies. This could include zero-emission vessel automated container movement technologies, advanced logistic strategies, and other equipment or strategies that enable more efficient operations. Improving the efficiency and logistics of ports could help reduce GHGs by

[9] For more information regarding CARB's regulatory activities for cargo handling equipment, visit https://www.arb.ca.gov/ports/cargo/cargo.htm

[10] A comparison of forklift propulsion systems is available at www.transportation.anl.gov/pdfs/TA/537.pdf.

reducing idling time, right sizing the amount of effort required to perform a specific task, and improving accuracy and scheduling in order to improve the movement of goods through the ports.

As an example, replacing manually-operated diesel-fueled cargo handling equipment with automatically controlled electric or fuel-cell electric hybrid vehicles and/or equipment using sophisticated software designed to more efficiently move goods within a facility is one of the many promising technologies that warrants consideration.

C. Ground Support Equipment

Similar to cargo handling equipment, airport ground support equipment (GSE) will play a role in future deployment of zero-emission off-road equipment. Zero-emission GSE is readily available and in widespread use in a number of applications, such as belt loaders, baggage tugs, and cargo tractors.

The types of GSE that could benefit from demonstrations are those applications that require higher tow and/or lift capacity and longer range. For example, aircraft tugs, with advanced batteries capable of heavier duty-cycles and longer range needed to reliably move heavier aircraft and move aircraft longer distances, could benefit from being demonstrated in a zero-emission application where the equipment dependably performs under all required airport conditions.

D. Locomotive Technologies and Operations

The baseline for locomotives is the current Tier 4 national emissions standards[11], and they conventionally meet these requirements through the use of diesel-electric configurations. The goal of this funding category is to demonstrate on-board energy systems in order to provide supplemental motive power and reduce fuel consumption and GHG emissions in a locomotive application. Some potential technologies this could include are energy storage solutions, such as batteries, and zero-emission energy generation systems, such as fuel cells, utilizing on-board storage or locomotive tenders.

One application that is of particular interest is a switcher application. Switching service consists of moving railcars from track to track (industrial switching or interchange tracks), between different locations on the same track (general movement within terminals or at junctions), and to and from trains (local or regional service). These applications could be a good fit for demonstrations because (1) areas of operations often occur in close proximity to disadvantaged communities, (2) given operations are concentrated in rail yards, so the energy demand may be met by battery and fuel cell technologies, and (3) demonstrations in these applications increase the potential for use of such technologies in higher horsepower applications such as class 1 line haul locomotives.

[11] For more information regarding the U.S. EPA's current locomotive standards, visit https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-locomotives

E. Non-Freight Categories (Agriculture, Construction, Passenger Transportation)

The main goals of this Solicitation for the identified non-freight categories are to transfer and expand the technology advancements from other categories, like the on-road truck and bus category, to off-road segments like agriculture, construction, and passenger transportation equipment, and support the expansion of energy storage systems into other transportation sectors.

The current state of the technology in these operations varies greatly between not only each category, but the equipment within each category as well. Potential projects should go above and beyond what has already been achieved and demonstrate advanced technologies that emit less GHG and criteria pollutant emissions than what is currently available for sale. As some examples, the types of technology that could fit into this demonstration include, but are not limited to, electric drive powertrains, hybridization, automation strategies leading to efficiency gains, engine efficiency technologies, advanced energy storage strategies, and new applications of zero- or near zero-emission technologies.

V. AVAILABLE FUNDING

The anticipated total CARB funding available through this Solicitation for off-road equipment is up to $17 million. If additional funds become available, and valid applications remain unfunded, those projects may be funded without reissuing a solicitation.

This Solicitation may fund such activities as production and deployment of prototypes, infrastructure, emissions testing, and practical demonstrations of technologies with a high potential to be commercialized. It may not be used to fund basic research, design-only projects, or commercial production. Field demonstrations of practical utility are required.

Funding is available for the following:

- Equipment, technology, and infrastructure production and installation;
- Demonstration of the deployed equipment, technology, and infrastructure;
- Administrative costs (administrative costs shall not exceed 5 percent of the project amount funded by CARB); and
- Data collection and emission testing.

To ensure equitable distribution of funding among potential Grantees as well as diversity in technology type, CARB, in its sole discretion, may apply the following caps to the funds available under this Solicitation:

- No more than 75 percent of the funding for projects under this Solicitation may be awarded to a single grantee;

- No more than 60 percent of the funding at any time may be allocated toward projects involving a single technology type (battery or battery dominant hybrid, fuel cell or fuel cell dominant hybrid, or other low CO_2 technologies).

If a single application contains differing technology types, the applicant will include in their proposed budget (outlined in Appendix A, Attachment 4) the total costs attributed to each specific technology type, and CARB will determine what percentage of the project will be considered for each technology type in order to properly adhere to the previously mentioned technology cap.

A majority of the total $17 million will be allocated to projects that adhere to the focus on freight applications, but a small amount of the funding may be available for off-road demonstration projects which are outlined as "non-freight" in the FY 16/17 Funding Plan. The eligibility criteria for such projects are outlined in Section IX, Eligible Projects. These non-freight proposals will have the opportunity to compete for up to $3 million out of the total $17 million under this Solicitation and will be scored against each other. Grants may be awarded to the top scoring non-freight proposal(s) totaling less than $3 million. The proposals for these projects must discuss the potential of the technology to be freight enabling after being successfully demonstrated (more details for this criteria are outlined in Section XV, Evaluation, Scoring, and Preliminary Selection). If CARB staff determines that the applicant has failed to adequately support the assertion that the demonstration is freight enabling, CARB, in its sole discretion, reserves the right to reject the application. CARB also reserves the right to not award any grants in this category.

In the event additional funding is provided from Low Carbon Transportation GGRF Investments for the Off-Road Advanced Technology Demonstration Project, these funds may be administered under this Solicitation at CARB's sole discretion.

VI. REQUIRED MATCHING FUNDS

The Grantee is required to match a minimum of 25 percent of the total project cost. Match funding must be provided in the following manner:

- A minimum of 10 percent of the total project cost must be in the form of cash committed by the Grantee, federal and local public agencies, project partners, and/or technology manufacturer (exclusive of providing in-kind contributions). Cash includes labor and capital outlays during the term of the Grant Agreement.

- Fifteen percent or more of the total project cost may be through some combination of in-kind contributions, such as labor, equipment, materials, equipment transportation, private financing, and federal; state; or local funds. Project facilities, laboratories, or real property will not be considered as part of a proposed in-kind match whether owned or leased by the Grantee or technology manufacturer.

While other publicly funded projects may work in coordination with this program, none of those funds or anything funded by those projects may be included in fulfilling any of the 25 percent match requirement. However, assets from publicly funded projects can be counted toward the 15 percent in-kind match if the contract requirements are complete at the time of the application. For example, electric charging or fueling infrastructure funded under another State project may be leveraged to support an Off-Road Advanced Technology Demonstration Project, but may only be used to meet part of the Grantee match requirements if the contract requirements with the State for that fueling infrastructure are no longer in effect.

The applicant may propose to use an in-kind administrative match contribution as an eligible expense for activities to be performed after the issuance of a preliminary award of funding and before the execution of the projects grant agreement. Such activities may include completing California Environmental Quality Act (CEQA) requirements, entering into sub-agreements with technology manufacturers and end-users, and performing other administrative activities required by the prospective grantee to enter into the grant agreement. However, an applicant does this at its own risk and with no guarantee that a grant agreement will be executed. CARB will not reimburse the prospective grantee for any costs incurred before the grant agreement is executed.

If a third party, (i.e., a party other than the Grantee or technology manufacturer) proposes to provide any part of the required match, the Grantee must include a letter from each third party stating that it is committed to providing a specific dollar value of cost sharing and the source of such funds. A Grantee and its partners must demonstrate technical and financial resources sufficient to meet their cost share commitment and complete the proposed project.

VII. ELIGIBLE GRANTEES

This competitive Solicitation is open to local air districts, other California-based public entities, or California-based non-profit organizations acting as the Grantee (applicant) for the application. The Grantee must demonstrate its expertise at implementing demonstration projects and providing administration and oversight for demonstration projects. Private sector parties (i.e., technology manufacturers and end-users) interested in demonstrating a strategy must partner with an air district, other California-based public entity, or California-based non-profit organization in submitting a demonstration application. Only projects from eligible Grantees will be scored.

Eligible applicants must meet all applicable requirements of State law and regulations, the AQIP Guidelines and FY 2016-17 Funding Plan, and this Solicitation. Specific requirements for the Grantee are further described in this Solicitation. To be considered for a grant award, applicants must fully complete the AQIP and Low Carbon Transportation GGRF Application (Appendix A) and demonstrate that they meet the Application Requirements (see Section XII of this Solicitation). CARB may request clarification regarding application responses during the application review process.

An eligible Grantee may request demonstration project funds without an identified technology manufacturer(s), provided they commit in the application to solicit for the project partners once funds are secured from CARB via this competitive Solicitation process. However, projects that already have all the needed participants, such as the identified end user of the proposed equipment, technology manufacturer(s), data analysis provider, and eligible Grantee will score higher than those that do not have team members identified in advance (see criterion 2 in Section XV, Evaluation, Scoring, and Preliminary Selection).

The public agency or non-profit organization will be required to submit a resolution of its governing board prior to execution of the Grant Agreement that commits the agency/organization to:

- Comply with the requirements of advanced technology demonstration projects;
- Accept the Grant funds from CARB; and
- Allocate any funding that the Grantee has committed to be part of a project application.

It is recommended that the resolution allow for grant amendments without governing board approval, if possible. If the public agency or non-profit organization does not have a governing board, then a binding written commitment from an official of the agency that has authority to enter into contractual obligations will be required to fulfill the above commitments.

If the public agency or non-profit organization that is submitting the application contributes a match to the project, the governing board resolution shall authorize the agency's or organization's legally authorized official to supply sufficient funding to meet the stated match commitment. Signed Grant Agreements and approved governing board resolutions need to be in place on or before the deadline listed in this Solicitation Timeline outlined in Section XIII, Application Instructions. Sub-agreements between the technology manufacturer(s) and the Grantee need to be in place before non-administrative work can begin.

VIII. RESPONSIBILITIES OF GRANTEE, TECHNOLOGY MANUFACTURER, AND DATA COLLECTION AND ANALYSIS PROVIDER

The entity proposing to be the Grantee will be responsible for administration of the demonstration project, and major responsibilities will include:

- Developing the project team, including technology manufacturer, end-user fleet, and data collection and analysis provider;
- Submitting the demonstration application to CARB;
- Administering the project;
- Coordinating press releases and press events;
- Ensuring completion of required CEQA documents;
- Overseeing technology manufacturer(s);

- Overseeing the project budget, completion of milestones, and verify receipt of deliverables and the amount of funds being used for the project's match requirement;
- Reporting to CARB on project status and Grant performance;
- Submitting periodic reports and Grant disbursement requests to CARB;
- Ensuring purchase, installation, and maintenance of data logging or other data collection equipment;
- Submitting data, as requested by CARB; and
- Coordinating periodic project status update meetings.

The technology manufacturer's major responsibilities in the demonstration project will include:

- Teaming with an air district, other public agency, or non-profit organization to develop the demonstration project application;
- Providing the technical expertise in performance of the demonstration;
- Timely achievement of stated demonstration project goals; and
- On-time reporting to the Grantee on project status and Grant performance.

The data collection and analysis provider's major responsibilities in the demonstration project will include:

- Teaming with an air district, other public agency, or non-profit organization to develop the demonstration project application;
- Installation and maintenance of data collection equipment on advanced technology and baseline off-road equipment;
- Coordination with CARB, Grantee, and technology manufacturer on data to be collected; and
- Collection, analysis, and reporting of collected data.

Progress reports from the technology manufacturer(s) shall be submitted to the Grantee at a minimum of three-month intervals. The Grantee is responsible for forwarding all progress reports, unaltered, to CARB within seven business days of receipt from the technology manufacturer(s) (see Reporting and Monitoring Requirements in Section XVII, Implementation Process). Additionally, every Grant disbursement request shall be accompanied by a progress report, in addition to any other required reports, that documents the time interval and the completion of specific project milestones, including any specific deliverables as defined for that milestone (see Project Funding Procedure in Section XVII, Implementation Process).

In order to ensure consistent data analysis across all heavy-duty demonstration projects, the specific data elements that will be required to be collected and required formats are listed in Appendix F, Data Collection Requirements.

Data collection will be required throughout the demonstration project, and the data gathered will be required to be submitted to CARB periodically and as part of project milestones and periodic project update reports. The Grantee must coordinate installation of data logging or other equipment to facilitate data collection. The types of data to be collected include, but are not limited to, fuel/electricity consumption, fueling/charging times, state of charge information, odometer readings, maintenance information, relevant telematics and GPS data, operating costs, hours of operation, idle times, temperatures, and user experience. Data collection and emission testing will also be required for baseline equipment, where appropriate. The Grantee will include as part of the project team a data collection and analysis provider. The Grantee will ensure that the data collection and analysis provider will have access to representative baseline pieces of equipment with comparable duty-cycles. Emission testing protocols will be approved by CARB, in its sole discretion.

A final report must be submitted to CARB from the Grantee at the conclusion of the demonstration project. The demonstration project will not be complete until the final report has been accepted by CARB. The final report will include, but will not be limited to, a summary of the progress reports, any deliverables that were committed to in the project, the results from any emission testing performed, and any other information required by CARB. The Draft final report is due to CARB no later than February 14, 2020, and the final report is due to CARB no later than March 30, 2020 (see Sample Grant Agreement, Appendix B). CARB retains the right to withhold up to 10 percent of the total award amount until delivery of the final report.

Additional reporting requirements are detailed in the Reporting and Monitoring Requirements in Section XVII (Implementation Process) of this Solicitation.

IX. ELIGIBLE PROJECTS

The projects covered by this Solicitation require the use of advanced technologies that achieve significant reductions in GHG, criteria pollutant, and toxic emissions that directly benefit disadvantaged communities. Only projects that provide benefits to disadvantaged communities, as specified in this Solicitation, will be scored. Projects that meet the criterion for being located within a disadvantaged community census tract will score more competitively, but projects that meet the criteria for providing a benefit to a disadvantaged community are also eligible for consideration for funding.[12] To determine whether a project qualifies as benefitting a disadvantaged community, applicants must use the criteria in CARB's Interim SB 535 Guidance.[13] Applicants are required to make an affirmation in their application Project Narrative (see Appendix A, Attachment 2) as to which criteria is being satisfied from Step 1 or Step 2 of Attachment 5 in Appendix A, and the reason that criteria has been satisfied, including any site- or route-specific information used to make that determination.

[12] The identified Disadvantaged Communities census tracts are available at http://www.calepa.ca.gov/EnvJustice/GHGInvest/.

[13] CARB 's SB 535 Guidance, Appendix A, contains the criteria for determining whether a project is located within a disadvantaged community or provides a benefit to a disadvantaged community. This Guidance is available at https://www.CARB .ca.gov/cc/capandtrade/auctionproceeds/final_supplemental_ggrf_funding_guidelines_12_30.pdf

The technologies for the projects funded under this Solicitation must not yet be commercially available in the application in which the technologies will be demonstrated (i.e., not yet produced for sale), but projected to be within three years of commercialization. Projects must support demonstration of full zero-emission and near zero-emission technologies in off-road equipment and either help support the sustainable freight action plan or be freight enabling. Fueling and charging infrastructure to facilitate the successful demonstration of technologies and logistics/operations efficiency improvements may also be included. In addition, projects that can build on synergies generated from established infrastructure investments and experience with existing zero-emission technologies are encouraged to apply.

Projects that would not provide a direct GHG benefit (e.g., projects that solely rely on the use of renewable fuel for their GHG emission reductions) are not eligible under this Solicitation.

Any projects that would involve demonstration of advanced technologies in an on-road application (e.g., on-road tractor or drivetrain technologies) are considered on-road projects and not eligible for funding under this Solicitation. Therefore, projects that would demonstrate advanced transport refrigeration unit (TRU) technologies are only eligible under this Solicitation if such projects do not include an on-road demonstration element.

The following project types, which were identified in the FY 16/17 Funding Plan[14], will be considered under this Solicitation:

- *Zero-Emission Cargo Handling Equipment*: Advanced zero-emission technologies in this category have tremendous potential to reduce emissions of GHGs and criteria pollutants because cargo handling equipment is widely used in California. Cleaner technologies in this category also have the potential for broad applicability in other sectors. Demonstrations for applications that have not yet reached commercial deployment could include zero-emission technologies for high lift capacity forklifts, reach stackers, and other cargo handling equipment operating at ports or intermodal rail yards. Eligible technologies are expected to provide zero-emission operation for at least part of the duty-cycle.

- *Zero-Emission Ground Support Equipment*: Projects should be designed to demonstrate advanced technologies and strategies that go beyond the current state of technology for airport ground support equipment and aircraft. Examples of technologies include battery electric, fuel cell electric, and flow batteries, and strategies that can reduce emissions from aircraft while being loaded or unloaded, taxiing, and queuing. Equipment is expected to be capable of zero-emission operation during a substantial part of its duty-cycle to be eligible.

[14] The full Fiscal Year 16/17 Funding Plan can be found at https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_full.pdf

- *Advanced Port Equipment*: Projects should be designed to demonstrate advanced technologies and strategies, such as zero-emission vessel automated container movement technologies, advanced logistic strategies, or other equipment or strategies that enable more efficient port operations.

- *Zero-Emission Locomotive Technologies and Operations*: Projects in this category are expected to demonstrate on-board energy storage systems to provide supplemental motive power to locomotives to reduce fuel consumption and GHGs as well as provide zero-emission operation for short periods. Projects could be designed to demonstrate locomotive tenders used for energy storage, such as batteries, and zero-emission energy generation systems, such as fuel cells, to facilitate zero-emission operation for part of the locomotive duty-cycle.

- *Non-Freight Off-Road Equipment:*
    - Advanced Technologies and Efficiencies for Agricultural Equipment: This category is intended to demonstrate and deploy advanced technologies that reduce GHG and criteria pollutant emissions for off-road mobile agricultural equipment. Projects could include low NOx engines, electric drive powertrains, hybridization, automation strategies leading to efficiency gains, and new applications for zero- or near zero-emission technologies.

    - Advanced Technologies and Efficiencies for Construction Equipment: This category is intended to demonstrate and deploy advanced technologies that reduce GHG and criteria pollutant emissions on off-road mobile construction equipment. Projects could include hybrid bulldozers or front loaders; new applications for zero- and near zero-emission technologies; and engine, powertrain, and automation strategies leading to efficiency gains.

    - Advanced Technologies for Off-Road Passenger Transportation: This category is intended to demonstrate advanced, emission-reducing technologies for in-state passenger transport. Ferry projects could include use of fixed wing sail technology that builds on successful past demonstrations or use of fuel cells or other technologies to reduce emissions. Passenger locomotive demonstrations could include fuel cells, hybrid technologies, advanced energy storage strategies, and other emission reduction technologies. Other project types may also be considered.

This competitive Solicitation is expected to accelerate zero-emission technology into the marketplace. Projects that can utilize full zero-emission technology may score higher than those technologies that only partially eliminate emissions (near zero-emission). Projects that specifically target freight equipment in order to support the California

Sustainable Freight Action Plan may also score higher.[15] The specific non-freight categories mentioned above will still be eligible for a smaller portion of the total funding (more details are outlined in Section V, Available Funding), but applications must include justification showing how the demonstration could be freight enabling. With such a diverse range of potential applications, projects selected under this Solicitation to demonstrate advanced technologies should be able to provide a significant improvement in air quality for many affected areas within the state when fully integrated into the marketplace.

X. SCOPE OF WORK

This section provides information on the project's scope of work. Any requirements identified below are minimum requirements and are not comprehensive. In addition to the information below, the scope of work includes reporting and monitoring requirements as detailed in Section XVII under the Reporting and Monitoring Requirements subsection.

All equipment funded under this Solicitation will be required to install data collection equipment that can track the equipment in real time and provide data on the position of the equipment and when it is in operation in a disadvantaged community as well as collect data on equipment operation. Minimum data collection elements can be found in Appendix F.

Practical field demonstrations are required for pieces of equipment funded under this Solicitation. Field demonstrations must be done while the pieces of equipment are in revenue service in their intended vocation by the fleet partner included in the project application. Field demonstrations should provide enough data to determine the economic viability for the continued use of the advanced technology pieces of equipment and must collect the relevant data items identified in Appendix F. Field demonstrations must be at least three months in duration, however, a field demonstration of six months or more will be more desirable.

A. Data Collection, Analysis, and Emission Testing

Data collection will be a required element of all funded projects. Data analysis, an important part of each project, will be accomplished by a member of the proposed project team. All types of data to be collected will be determined at CARB's sole discretion, in consultation with the project's technology manufacturer(s), data collection and analysis provider, and Grantee. All project team participants must work cooperatively with the data analysis provider and supply data as requested in a timely manner. The sharing of data collected from pieces of equipment, infrastructure, operators, and other relevant equipment with the project team and CARB is required.

[15] CARB et al. California Sustainable Freight Action Plan; July 2016; http://www.casustainablefreight.org/theplan.html.

Reproducible emission testing for internal combustion engines to verify the emission benefits from the demonstration of technologies funded under this Solicitation will be required to be performed. If NOx emissions are being measured, the result will be shown as NOx and nitric oxide (NO) plus nitrogen dioxide (NO_2). The emission testing procedure used to verify emission reductions should be cited in the project's narrative (see Appendix A, Attachment 2). The final emission testing procedure will be subject to CARB approval.

A "well-to-wheel" analysis to quantify greenhouse gas emission reductions is required for all equipment funded under this Solicitation. The applicant is required to determine the resulting emission reductions associated with their project (see Appendix D for the methodology). All calculations must be shown in their entirety and included in the application (see Appendix A, Attachment 3). Incomplete illustration of the mathematical processes used will result in no points being allocated for scoring criterion 6 and reduced points allocated under scoring criterion 11 in Section XV, Evaluation, Scoring, and Preliminary Selection, as well as possible disqualification.

If the applicant believes the methodology for determining emission reductions and cost effectiveness is not representative, the applicant may use an alternative methodology to calculate the potential emission reductions and cost effectiveness. In such case, the applicant must submit:

- Emission reductions and cost effectiveness determined in accordance with the applicant's alternative methodology;
- Emission reductions and cost effectiveness determined in accordance with the required methodology as outlined in Appendix D; and
- A description as to why the methodology outlined in Appendix D does not accurately represent their emission reduction potential.

Projects will only be scored based on the required methodology for determining emission reduction and cost effectiveness.

Data collected from emission testing as part of a selected demonstration project and data included in the project's submitted work plan and scope of work can be applied toward CARB or United States Environmental Protection Agency (U.S. EPA) certification or verification. However, AQIP funds or GGRF Low Carbon Transportation investments cannot be used directly to fund formal CARB or U.S. EPA verification or certification processes.

If the project uses any engine, retrofit, or piece of equipment that has been or will be funded in whole or part by another public program and is still under contractual obligations, the equipment and the contract status must be identified in the project's narrative. Furthermore, the project narrative must also include a plan to ensure that emission reductions are not concurrently counted toward this Solicitation (see Appendix A, Attachment 2).

B. Vehicle Certification, Verification, and Permitting

All vehicles in the proposed project that will be operated on California roadways must be compliant with all State requirements, including, but not limited to, CARB Experimental Vehicle Permitting, Department of Motor Vehicles licensing, California Highway Patrol requirements, and others. Further, the operational demonstration of the proposed vehicles must be approved by the intended operators, and the confirmation of such approval must be indicated in the operator's letter of support. A clear explanation of what steps are required in the process for legal operations on California roadways, usage on port properties, rail yards, and other sites where the vehicle will be operated, must be indicated. Instructions will not be provided as part of this Solicitation as to the pathway to certification or verification.

As part of a viable commercialization plan CARB verification or certification, as required, must be the ultimate goal of all vehicles and equipment funded under this Solicitation. For any technology that will require CARB verification or certification or U.S. EPA certification or consideration, the applicant must explain in the project narrative the steps that will be followed to accomplish required government certification and verification protocols. Projects selected for funding will require all submittals of documents to non-CARB certifying authorities to be concurrently submitted to CARB and discussed during the routine Project Update meetings as outlined in Section XVII, Implementation Process.

C. Repowers and Conversions

Projects containing a repower or conversion component will be required to meet certain criteria. Repower means removing an existing internal combustion engine and replacing it with a near zero-emission hybrid system that includes a new internal combustion engine that meets a more stringent emissions standard, regardless of the beginning and ending fuel types (e.g., a 2005 model year diesel engine repowered with a 2014 model year natural gas engine). A conversion means removing the existing internal combustion engine and replacing it with a zero-emission system (e.g., a diesel-fueled vehicle converted to an electric vehicle or fuel cell vehicle). The following criteria apply to repowers and conversions:

- An off-road piece of equipment repowered with a hybrid system must achieve at least some zero-emission operation during its duty-cycle. Projects will be scored according to the amount of zero-emission operation the piece of equipment can perform during one full duty-cycle (e.g., a repower with a hybrid-electric system that can achieve all-electric operation during 50 percent of an entire duty-cycle will score higher than one that can achieve all-electric operation during 25 percent of an entire duty-cycle).

- Conversions or repowers of existing pieces of equipment are limited to pieces of equipment that the applicant can demonstrate will have a remaining useful life of at least 10 years.

D. Fueling Infrastructure

Infrastructure necessary for operating equipment that is the subject of this Solicitation is an eligible cost. Proposed infrastructure should be capable of allowing a robust and significant field demonstration of the proposed technology. Projects that propose only infrastructure without accompanying pieces of equipment will not be scored.

CARB will only process applications for infrastructure projects where the project is proposed to be sited where similar infrastructure already exists (e.g., installing electric vehicle supply equipment where electrical infrastructure already exists, or installing a hydrogen refueling station at an existing fueling station or industrial facility). Proposed projects that can synergistically take advantage of existing fueling or charging infrastructure should show a cost-effective advantage to other proposed projects that will require stand-alone infrastructure to be installed as part of a project. In addition to a cost-effective advantage, projects which utilize existing fueling or charging infrastructure will most likely require less time to start demonstrating the technology, and this has the potential advantage of showing that the demonstration can feasibly complete all work by March 30, 2020.

Emission reductions associated with any infrastructure funded by this Solicitation are not allowed to be included as part of the emission reduction totals that will be considered during proposal scoring. In other words, emission reductions will only be assigned to the advanced technology equipment funded under this Solicitation.

Proposed infrastructure costs must be substantiated by qualified entities with experience in the installation, permitting, and commission of the proposed infrastructure type. Any infrastructure proposal should indicate all the required steps including, but not limited to, siting, permitting, safety certifications, and other necessary certifications. Operation and maintenance of any proposed infrastructure must be addressed in the project application budget. The amount of funds proposed in the application for infrastructure that will be funded by the grant will be the total amount of funds that CARB will devote to infrastructure funding. **NOTE: If the actual infrastructure costs exceed the proposed amount of funds allocated in the application, the difference must be covered by the applicant.**

Charging/refueling stations that, in addition to the project equipment, allow other advanced technology vehicles not being funded, such as zero-emission commercial medium-duty trucks and buses or private light-duty electric or fuel cell vehicles, to charge/refuel are encouraged and may be scored higher.

1. *Hydrogen Refueling Stations*

Proposals containing a hydrogen refueling station installation must adhere to the minimum technical requirements and renewable hydrogen requirements specified in Appendix C and the CEQA and permitting requirements described in Appendix E. Additionally, the project must comply with all applicable federal, state, and local laws and requirements for acceptable installation and usage of hydrogen refueling stations. Each hydrogen refueling station must be designed to allow the hydrogen refueling station to accept delivery of hydrogen fuel from a mobile refueler or hydrogen tube trailer if on-site hydrogen production goes off-line or if hydrogen delivered via a pipeline is disrupted. Public or private access to refueling from proposed refueling stations is not required. However, infrastructure proposals designed to allow refueling by non-project entities during or following the completion of the demonstration project may score higher than those that do not allow refueling by non-project entities. As noted above, CARB will only process applications for infrastructure projects (including hydrogen refueling stations) where the project is proposed to be sited where similar infrastructure already exists (e.g., installing a hydrogen refueling station at an existing fueling station or industrial facility).

2. *Electric Vehicle Supply Equipment*

Proposals containing electric vehicle charging infrastructure installation must adhere to the CEQA and permitting requirements described in Appendix E, and the project must comply with all applicable federal, state, and local laws and requirements for acceptable installation and usage of electric vehicle supply equipment (EVSE). For the purposes of this Solicitation, EVSE is meant to include all equipment necessary to charge a piece of advanced technology equipment that is not inherently incorporated within the vehicle itself. Any proprietary protocol may additionally be superimposed on the system, provided the site owner is able to revert to the open standard protocol. The proposal must include a maintenance plan for continued reliable operation and unforeseen breakdowns of the EVSE. Public access to charging from proposed EVSE is not required. However, projects designed to allow charging by non-project entities during or following the completion of the demonstration project may score higher than those that do not allow charging by non-project entities. As noted above, CARB will only process applications for infrastructure projects (including EVSE installations) where the project is proposed to be sited where similar infrastructure already exists (e.g., installing electric vehicle supply equipment where electrical infrastructure already exists).

XI. PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY

CARB will not make any claims as to ownership of equipment funded by this grant. However, all information and data generated under the Grant Agreement are the property of CARB. Additionally, the technology manufacturer(s) and Grantee will make available any information and data needed to satisfy the requirements discussed in Section XVII under the Reporting and Monitoring Requirements subsection.

Data gathered on actual emissions to the air as part of this demonstration project cannot be protected from disclosure. Any information determined to be a trade secret or otherwise exempt from disclosure under the California Public Records Act or other provisions of law must be labeled “confidential.” Review Appendix A, Attachment 6 for Procedures for Handling Confidential Information. If you wish to include confidential information, you must:

- Complete the Confidentiality Provision (Appendix A, Attachment 6) and attach it to your application;
- Separate confidential pages from the other elements of the application (do not

include any confidential information in the main application) and submit them as a separate cover; and

- Clearly label every confidential page as "CONFIDENTIAL."

Applications will be reviewed by CARB staff and may include reviewers outside of CARB associated with public universities in California and other State government agencies as needed. The applicant should not include any confidential information in the main application and should only reference the existence of the confidential information under the separate cover. Please provide the name, address, and telephone number of the individual to be contacted if CARB receives a request for disclosure of the information claimed as confidential. CARB may share confidential information related to a demonstration project (such as certification/verification data) with multiple units and sections within CARB or other relevant State agencies.

XII. APPLICATION REQUIREMENTS

Eligible Grantees must meet all applicable requirements of State law and regulations, the AQIP Guidelines, the Funding Plan, and this Solicitation. To be considered for the grant award, Grantees must complete the application and demonstrate that they meet the required Solicitation elements. CARB may request clarification regarding application responses during the application review process. Only applications that contain all of the required elements as described in the Required Application Elements section and Appendix A of this Solicitation will be scored.

Please enclose with your application any documents (or pertinent excerpts) that you cite in support of performance claims in your project. However, only materials containing the information requested in these instructions should be supplied. CARB will not review patent documents, engineering drawings and specifications, or promotional materials. Include in your application package letters of support from project partners that describe the nature of their contribution to the project.

Letters of support from non-project partners are discouraged and are not part of the scoring criteria. However, letters of commitment from community groups that are part of the project team are required and should detail the level of support for the project and describe what role the community group plays in the project. Further, letters should discuss the level of support the project has in the disadvantaged community(ies) where the project is located and/or providing benefits to, and indicate the group's role in the community. Strong support from community groups may score more competitively under the Benefits to Disadvantaged Communities Scoring Criteria 8, described in Section XV Evaluation, Scoring, and Preliminary Selection section.

The submitted application package must include four (4) copies in addition to the signed original and one (1) compact disc (CD). The CD must contain the application package, including all required documents, as a single electronic file in either Microsoft Word or Portable Document Format (PDF). Applications that do not meet the above requirements may not be scored and may be disqualified.

Required Application Elements

CARB requires applications to be accurate, and applicants are strongly encouraged to ensure their applications are brief and clear. Applications will be initially screened for completeness; incomplete applications will not be scored. The application of this Solicitation is included as Appendix A - AQIP and Low Carbon Transportation GGRF Application. Applications must be signed, be dated, and include the following required elements:

- Attachment 1: Project Executive Summary and Project Summary for Public Posting
- Attachment 2: Project Narrative and Work Plan
- Attachment 3: Emission Reduction and Cost-Effectiveness Calculations
- Attachment 4: Proposed Budget, Project Milestone, and Disbursement Schedule
- Attachment 5: Disadvantaged Communities Eligibility Determination
- Attachment 6: Procedures for Handling Confidential Information
- Attachment 7: California Environmental Quality Act Worksheet (if applicable)
- Attachment 8: Letters of Commitment
- Attachment 9: Applicant Qualifications
- Attachment 10: Conflict of Interest Declaration
- Attachment 11: STD. 204 Payee Data Record (**required even if applicant is a public entity**)

XIII. APPLICATION INSTRUCTIONS

Appendix A contains the forms and information necessary for submittal of a complete application. CARB will select a Grantee based upon the scoring criteria identified in this Solicitation. All information and data submitted as a response to this Solicitation are the property of CARB and will become a public record. If no qualified proposal is submitted, CARB will not award a grant and will re-evaluate this Solicitation to re-solicit for applications or consider other options at CARB's sole discretion.

If you need this document in an alternate format or language, please contact Nathan Dean at (626) 575-6998 or nathan.dean@arb.ca.gov. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

One (1) signed original, four (4) copies, and one (1) CD of the application, including all of the required documents, must be received at the California Air Resources Board at 9480 Telstar Ave No. 4 El Monte, CA 91731. The CD must contain the application and other required documents, all in a single Word or PDF file.

Applications must be mailed to the following address:

California Air Resources Board
Mobile Source Control Division
9480 Telstar Avenue No. 4
El Monte, California 91731
Attention: Nathan Dean

Applications submitted must be dispatched with enough time to be received by CARB no later than **5:00 p.m. (Pacific Time) on September 7, 2017** (delivery service provider tracking number may be used to verify date of receipt) to the address below. Applications received after September 7, 2017 may be rejected and not scored.

Once the application is mailed or delivered in person, please send an email to Nathan Dean at nathan.dean@arb.ca.gov indicating that you have submitted an application. Sending this email informs CARB staff that your formal application is on the way and secures one of the five points provided for Application Completeness. A confirmation email will be sent within 24 hours to the applicant upon receipt of the hardcopy application. **No applications may be submitted by fax or email.**

*Solicitation Timeline**

Key Actions	Dates	Time (Pacific)
Public Release of Solicitation	June 9, 2017	--
Applicant Question Deadline	July 3, 2017	5:00 pm
Applicant Teleconference	July 6, 2017	10:00 am
Application Submittal Deadline	**September 7, 2017**	**5:00 pm**
Preliminary Grantee Selection	October 20, 2017	5:00 pm
Final CEQA Documentation Submittal Deadline**	November 17, 2017	5:00 pm
Execute Grant Agreement and Return to CARB***	December 15, 2017	5:00 pm
Sub-Agreement Process Complete	January 12, 2018	5:00 pm

* Timelines are subject to change at CARB's sole discretion.
** This step only applies for projects containing infrastructure proposals where an agency other than CARB is the lead CEQA agency for the project.
*** Includes governing board resolution.

XIV. APPLICANT TELECONFERENCE

CARB will hold an Applicant Teleconference where staff will be available to answer questions potential applicants may have regarding eligibility, application completion, and other requirements. The Applicant Teleconference will take place on the following date and time:

Date: July 6, 2017
Time: 10:00 a.m. – 12:00 p.m. (Pacific Time)
Place: California Air Resources Board
9528 Telstar Avenue
El Monte, California 91731

Teleconference Information:
Call-in Phone Number: 888-950-8046
International Number: 1-210-234-0044
Passcode: 5157729

The Applicant Teleconference will be open to all interested entities and the intent is to provide potential project applicants with an opportunity to ask clarifying questions regarding this Solicitation package and the project requirements. Written questions submitted prior to the Applicant Teleconference will be given priority. Questions should be emailed to Nathan Dean at nathan.dean@arb.ca.gov up to 5:00 p.m. (Pacific Time) two business days prior to the Applicant Teleconference. The questions and answers from the Applicant Teleconference including those received via email will be posted on the CARB website by **5:00 p.m. (Pacific Time) on August 7, 2017**; this date may be extended at CARB's sole discretion. CARB will not answer questions regarding this Solicitation after the Applicant Teleconference. Any verbal communication with a CARB employee concerning this Solicitation is not binding on the State and shall in no way alter a specification, term, or condition of the Solicitation.

XV. EVALUATION, SCORING, AND PRELIMINARY SELECTION

CARB will evaluate all eligible project applications based on the same scoring criteria described below. The maximum score is 120 points. The qualified applicant(s) with the highest overall score(s) will be preliminarily selected as Grantee(s).

The preliminary selection of a project does not in any way commit CARB to approving the grant. The selected applicant will be required to sign a Grant Agreement with CARB to fulfill the duties of Grantee (see Appendix B). The Grant Agreement may not be executed unless and until any required CEQA review has been completed. For a project where an agency other than CARB is serving as lead CEQA agency, the applicant must submit any required final CEQA documents by November 17, 2017 (prior to execution of the Grant Agreement). If an applicant fails to meet this requirement, CARB may deny the grant application. CARB will independently review any CEQA documentation provided by the applicant. CARB may modify any Grant Agreement based upon information produced from the CEQA environmental review process. If

CARB in its sole discretion finds a project's CEQA documentation inadequate, CARB retains absolute sole discretion to either (1) modify the grant agreement as necessary to comply with CEQA, (2) select other feasible alternatives to avoid significant environmental impacts, or (3) deny the grant application.

No legal obligations will exist unless and until the parties have executed and delivered a Grant Agreement, as informed by information produced from the CEQA environmental review process (to the extent applicable). CARB, in its sole discretion, may cancel the proposed grant and make a selection to the next highest scoring project, and so on, until an agreement is reached, or exercise its right, in its sole discretion, throughout this process to not award a grant. CARB reserves the right, in its sole discretion, to cancel this Solicitation, re-solicit for a Grantee, or direct funding to another project in the Funding Plan. In the event funding has been awarded to the highest scoring project(s), and the remaining available funds are less than the amount requested in the next highest scoring application, CARB, in its sole discretion, may offer funding to the next highest scoring project(s) that request less than the remaining available funds, carry the remaining funds forward to the next fiscal year, shift the funds to another project category, or not award a grant.

It is anticipated that up to $17,000,000 for all selected projects will be available under this Solicitation. If additional funds become available, and valid applications remain unfunded or if a funded application can be expanded beyond the original scope outlined in their application, those projects may be funded without reissuing a solicitation at CARB's sole discretion.

If two or more applications are submitted for the same project by different applicants, those applications will be scored separately, and the highest scoring project will then compete against applications submitted for different projects.

If the application involves technology that would not be demonstrated in conventional freight equipment[16] and the applicant is applying for the $3 million available for non-freight categories, the applicant must describe how the successful demonstration of the technology could be freight enabling and support the California Sustainable Freight Action Plan.[17] This may include, but is not limited to, providing evidence showing strong potential for technology transfer from the non-freight application, in which the technology would be demonstrated, into a freight application. CARB, in its sole discretion, reserves the right to reject an application if staff has determined that the applicant has failed to adequately support the assertion that the demonstration is freight enabling. More details on the $3 million for non-freight categories can be found in Section V, Available Funding.

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[16] Solely for the purposes of this Solicitation, the four freight categories and TRUs outlined in Section IX, Eligible Projects, will be considered conventional freight.

[17] CARB et al. California Sustainable Freight Action Plan; July 2016; http://www.casustainablefreight.org/theplan.html.

CARB reserves the right to remove discrete elements of projects selected for funding that CARB determines to be ineligible.

Applications that already have sub-agreements in place with all the proposed project partners may score more competitively under the Project Team Capabilities and Degree of Industry Collaboration Scoring Criteria 2, which is described in this section.

Only eligible projects will be scored, and only eligible equipment will be scored and considered for funding. To be eligible, applicants must demonstrate in the Project Narrative (see Appendix A, Attachment 2) that the proposed project would provide benefits to disadvantaged communities, as outlined in Section IX, Eligible Projects. Other elements are also required to be included in each application as indicated in this Solicitation (see the Required Application Elements area in Section XII, Application Requirements). Further information on determining benefits to or being located within disadvantaged communities can be found in Appendix A, Attachment 5.

In the event that one or more projects cannot be fully funded because the requested amount exceeds the available remaining funds, CARB in its sole discretion may offer to fund those projects at a lesser amount at a scaled down scope. If the project applicant declined funding at the reduced project scope, CARB may offer funding to the next highest scoring eligible application, either fully or at a scaled down scope, carry the remaining funds forward to the next fiscal year, shift funds to another project category, or not award a grant(s).

Summary of Scoring Criteria for Demonstration Projects

	Scoring Criteria	**Points**
1	Applicant Qualifications	5
2	Project Team Capabilities and Degree of Industry Collaboration	20
3	Project Objectives and Work Plan	15
4	Timeline for Project Completion	10
5	Budget, Match Funding, and Financial Capabilities	10
6	Potential Emission Reduction Benefits	10
7	Cost-Effectiveness	5
8	Benefits to Disadvantaged Communities	10
9	Technology and Innovation	15
10	Potential for Market Penetration and Commercialization	15
11	Application Completeness	5
	TOTAL	**120**

Applicants will be evaluated based on the Scoring Criteria. The Project Narrative and Work Plan must address how the applicant will implement all of the tasks in the proposed scope of work.

Scoring Scale

Using the scoring scale below, the evaluation team will score each eligible application for each scoring criteria described within this Solicitation.

Possible Points	Interpretation	Explanation for Percentage Points
0%	Not Responsive	Response does not include or fails to address the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
10-30%	Minimally Responsive	Response minimally addresses the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
40-60%	Inadequate	Response addresses the requirements being scored, but there are one or more omissions, flaws, or defects or the requirements are addressed in such a limited way that it results in a low degree of confidence in the proposed solution.
70%	Adequate	Response adequately addresses the requirements being scored. Any omission(s), flaw(s), or defect(s) are inconsequential and acceptable.
80%	Good	Response fully addresses the requirements being scored with a good degree of confidence in the Applicant's response or proposed solution. No identified omission(s), flaw(s), or defect(s). Any identified weaknesses are minimal, inconsequential, and acceptable.
90%	Excellent	Response fully addresses the requirements being scored with a high degree of confidence in the Applicant's response or proposed solution. Applicant offers one or more enhancing features, methods, or approaches exceeding basic expectations.
100%	Exceptional	All requirements are addressed with the highest degree of confidence in the Applicant's response or proposed solution. The response exceeds the requirements in providing multiple enhancing features, a creative approach, or an exceptional solution.

The **PROJECT NARRATIVE** must separately address each of the scoring criteria listed below; see instructions for the Project Narrative in Appendix A, Attachment 2.

1. **Applicant Qualifications – 5 points**
   Describe the experience and expertise the proposed Grantee has in implementing large-scale air quality incentive projects or programs and working with off-road vehicle and equipment manufacturers, technology providers, and other key project stakeholders. Scoring will be based on the applicant's ability to successfully act as Grantee according to their demonstrable staffing, infrastructure, funding, and other available resources.

2. **Project Team Capabilities and Degree of Industry Collaboration – 20 points**
   - Proposals that identify the end user of the equipment to be used in the project, the technology manufacturer(s), the data analysis provider, and the Grantee will score higher than those that do not have all the needed participants identified in advance.

   - Proposals that have all needed sub-agreements in place with the proposed project partners will score higher than those applications that do not have sub-agreements in place before the application is submitted.

   - Describe the roles and the work to be performed by each of the project's key participants, including project administration, project planning, field demonstration, and data collection and reporting.

   - Describe the administrative and technical qualifications and capabilities of key personnel, such as education and training, research and professional experience (which could include, but is not limited to, experience with advanced technology vehicle manufacturing, operation and maintenance of advanced technology vehicle fleets, zero-emission fueling infrastructure operation and maintenance, workforce training, and/or administering outreach and education programs), publications (patents, copyrights, and software systems may be provided in addition to or substituted for publications), and ability to administer similar air quality programs.

   - Describe the capabilities of the project team to increase scalability of the technology after the project is successfully demonstrated. This could include, but is not limited to, ability or experience ramping up production in a timely manner, increasing sales volumes, performing production testing, and providing support for large scale volumes of products.

   - Describe the project team's relationship and degree of collaboration with vehicle and charging/refueling infrastructure builders and technology manufacturer(s) on the proposed project. Describe what business alliances and partnerships will be involved in commercialization.

- Performance of the Grantee, technology manufacturer(s), and other project participants with previous AQIP projects will also be considered.

3. Project Objectives and Work Plan – 15 points

- Provide a concise statement of how the project meets CARB's goals under the Off-Road Advanced Technology Demonstration Project Solicitation and the FY 2016-17 Funding Plan.

- In a logical sequence, describe the tasks necessary to prepare for and conduct a practical demonstration of the innovative technology(ies). Tasks should be divided into the phases of the project, as appropriate, and described in enough detail for reviewers to understand the scope of the work. Identify what entity (Grantee or industry partner) will perform each task.

- Provide quantitative milestones for each budget period of the project, and identify them with a number, title, and planned completion date. The general duration for each task must be specified. Identify at which milestones disbursement requests will be made, at what amounts, and the deliverables associated with each milestone.

- Identify the entities that will be using the pieces of equipment included in the project and how the Grantee will ensure data will be reported as required to CARB.

- Identify the resources (e.g., equipment, machine and electronic shops, field and laboratory facilities, materials, etc.) to be used at each performance site listed. Describe only those resources directly applicable to the proposed work, listing important items of equipment already available for this project. If proposing an equipment acquisition, describe comparable equipment, if any, already at your organization and explain why it cannot be used.

- Identify workforce training necessary to ensure successful execution and completion of the proposed demonstration project, including, but not limited to, training for vehicle operation, refueling, vehicle maintenance and repair, and data collection.

- Describe how the funded project equipment will be used and the expected dispositions of the funded project equipment and infrastructure after the end of the term of the grant agreement.

- For proposals that include near zero-emission equipment, specify the routes and/or conditions where project equipment will be operated in zero-emission only mode including zero-emission only operation within disadvantaged community ZIP codes, and, if applicable, describe the geofencing technology to be employed for ensuring and documenting that zero-emission only operation has occurred according to the project description.

- Identify the extent to which renewable sources of energy will be used to support the zero- or near zero-emission technologies to be demonstrated. Projects employing a higher percentage of renewable energy will score higher than those employing a lower percentage or no renewable energy.

- Identify any fueling, charging, or other related infrastructure already in place that will be utilized during the proposed demonstration project and the agreements planned or already in place to utilize the existing infrastructure.

- Specify if any mobile refueling will be included in the project and agreements planned or already in place to provide mobile refueling to funded equipment.

- Identify any infrastructure, including charging and refueling infrastructure, that will need to be installed to allow proper use of the equipment identified in the project and a brief description of the process for planning and installation. Identify the entities that will be doing the infrastructure installation and at what cost. Describe plans, if any, for future use of charging and refueling stations following the demonstration project.

- For proposals that include installation of a hydrogen refueling station to be funded as part of the project, provide a description of how all of the components of the Hydrogen Refueling Station Requirements (Appendix C) will be met. The proposal must include overall station performance parameters including, but not limited to, fuel quality, metering accuracy, fueling protocol, pressures, storage, compression, daily throughput, hourly peak throughput, and a plan that ensures these parameters are maintained.

- For projects that include electric vehicle supply equipment (e.g., charging stations), identify the analysis that has been accomplished, if any, to identify and/or address grid impacts during peak electricity demand hours.

- For proposals that include fueling or charging infrastructure installation to be funded as part of the project, include information showing the infrastructure is designed and engineered to match the specific minimum fueling/charging needs of the proposed fleet. The proposal must include descriptions of the station parameters that must be met and of the “space or area” where the parameters will be displayed. The description of the parameters must be appropriately placed in close proximity to the station and in an easily accessible area for the users of the fueling/charging equipment. Details must be provided explaining the existing similar infrastructure where the funded infrastructure is proposed to be sited (e.g., existing electrical infrastructure where proposed EVSE is to be sited, or an existing fueling station or industrial facility where a proposed hydrogen refueling station is to be sited). In cases where the applicant would make the funded infrastructure available to non-project fleets, the proposal must include information showing how the applicant will plan for capacity adjustments to handle the additional demand.

- The Project Objectives and Work Plan must address how the applicant will implement all of the tasks in the proposed scope of work.

4. Timeline for Project Completion – 10 points

- Provide a project schedule including the milestones as described in the Project Narrative and Work Plan section of Appendix A, Attachment 2. Both a tabular and graphic display (such as a Gantt chart) of the project schedule is preferred, but at a minimum, a tabular display is required. Information must include task duration, start and completion dates, and expected time to secure materials and construction services, in addition to the milestones being clearly identified. The milestones and timelines must also include all infrastructure installation that is to be funded as part of the project.

- Demonstrate that all work will be accomplished by March 30, 2020.

5. Budget, Match Funding, and Financial Capabilities – 10 points

- Provide a clear and concise project budget that lists all expenditures and the sources of funds in a logical sequence that leads to on-time completion of the project (see sample budget in Appendix A, Attachment 4). Administrative fees may not exceed 5 percent of the total amount awarded by CARB.

- Create a list of tasks required to successfully complete the demonstration and indicate the source of funding and amount of funds for each task.

- Clearly display the amount of funds being used as match for the project. Funds identified as match must also indicate what entity is providing the match and if the match is part of the cash match or in-kind match.

- Demonstrate that the Grantee and/or technology manufacturer(s) will be financially capable of providing the minimum 25 percent match requirement of the total project budget (including the 10 percent cash requirement exclusive of in-kind contributions). Higher match pledges will be scored higher. See section VI, Required Match Funds for more information.

- Describe each financial contribution to the project (match funding or other leveraged funding), and specifically indicate which current and pending funding sources would be used for the required cost share match. Identify if all or a portion of the match funding is dependent upon successful grant award under any other solicitation.

- Attach Letter(s) of Commitment from each project partner stating, if applicable, that it is committed to providing a specific minimum dollar amount of cost sharing as part of the match funding requirement or as other leveraged funding. Letters must be signed by the person authorized by the entity to commit the expenditure of funds.

6. **Potential Emission Reduction Benefits – 10 points**
   - Describe in Appendix A, Attachment 3, the estimated reductions of GHG, criteria pollutant, and PM emissions as determined by using the methodology in Appendix D. Combined weighted criteria pollutant and PM emission reductions are to be based on exhaust emissions (tank to wheel) and calculated in tons reduced per year. The GHG emission reductions are to be based on life cycle analysis (well to wheel) and calculated in tons of CO_2 equivalent[18] reduced per year.

   - **<u>Show all math used in calculations</u>.** Cite all sources and explain all variables used in the calculations not included in Appendix D.

   - Describe the utility of the innovative technology to help California achieve its climate change and air quality goals by reducing GHG, criteria pollutant, and toxic air contaminant emissions, particularly in disadvantaged communities.

   - Briefly describe what the emission benefits could be in California once the equipment is successfully demonstrated and commercially accepted. No calculations for this point are required, but discuss the inventory of the specific type of equipment being demonstrated and explain what level of widespread emission benefits could be achieved within the state once the technology is fully integrated into the marketplace.

   - If an alternative methodology is used to calculate the emission reductions for this project, all math should be shown and all values should be cited. Alternative methodologies will not be used to score the project but may provide insight to the scoring team on the potential emission reductions of the project.

7. **Cost-Effectiveness – 5 points**
   - Describe in Appendix A, Attachment 3 the estimated cost-effectiveness of the project in dollars per ton of combined criteria pollutant and weighted PM emissions reduced, and per ton of GHG emissions (in CO_2 equivalent) reduced for the two scenarios below, using the methodology in Appendix D:
     - during the actual proposed project over a 2-year demonstration; and
     - once deployed into the marketplace, one year post proposed demonstration with a useful life of ten years

   - If an alternative methodology is used to calculate the project's cost-effectiveness for this project, all math should be shown and all values should be cited. Alternative methodologies will not be used to score the project but may provide insight to the scoring team on the potential emission reductions of the project.

[18] "CO_2 equivalent" means the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas.

8. Benefits to Disadvantaged Communities – 10 points

- Describe the location of the hub(s) where the project equipment will be domiciled, including the physical address with zip code.

- If the equipment will be operated in areas outside of the location stated, provide a general description of the routes to be driven by the project equipment including, but not limited to, names of the cities they will travel or operate in and amount of time spent in these different locations.

- For projects including near zero-emission equipment, describe how zero-emission only operation will be ensured while the project equipment is operating in disadvantaged community zip codes.

- Describe how the project will benefit a disadvantaged community. All projects must meet at least one of the criteria in CARB's Interim SB 535 Guidance for being located within, or providing benefit to, a disadvantaged community.[19]

- Describe how the proposed project addresses one or more common economic needs of disadvantaged communities, including, but not limited to, those listed in Appendix A, Attachment 5.

- Describe any community based organizations that support the proposed project and any plans for ongoing engagement with those organizations.

- For commitments from community groups that are part of the proposed project team, indicate the level of support and what role the community group will play in the proposed project.

- Projects that meet the criterion for being located within a disadvantaged community census tract will be scored higher than those that meet one of the criteria for providing a benefit to a disadvantaged community, but are not located within the census tract. Projects that do not meet any of the criteria in CARB's Interim SB 535 Guidance[18] will not be considered for funding.

9. Technology and Innovation – 15 points

- Identify and describe the technological innovation that is the basis for the project. If the proposed technology is a component of a device or process, also describe the device or process. Descriptions should be understandable to reviewers who are not experts in the field. Cite (but do not include) patents if needed. Describe exactly what part of the technology is innovative, how it is innovative, and how it works.

[19] Use the criteria contained in CARB's Interim SB 535 Guidance, Appendix A, to determine whether a project is located within a disadvantaged community or provides benefit to a disadvantaged community. This Guidance is also available at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/final535-interim-guidance-11-3-2014.pdf.

- Describe what safety measures are in place to ensure safe operation and maintenance of the equipment during operations, battery charging, refueling, equipment maintenance, and other situations where interactions with the equipment take place. Identify any specific issues that first responders, such as firefighters, police, etc., should be concerned with if an emergency is encountered, either due to internal or external forces, with the piece of equipment or infrastructure funded under this demonstration.

- Explain the technical advantages of the innovation, and document performance claims.

- Describe what type of emission testing has already been done on the proposed technology(ies), if applicable.

- Describe the potential to develop the technology beyond the demonstrated scope and transfer into other applications, duty-cycles, types of equipment, and/or mobile sectors.

10. Potential for Market Penetration and Commercialization of the Technology – 15 points

- Define target markets and explain why the targeted industries would buy the innovation after a successful demonstration project. Both markets within and outside of California should be considered.

- Describe the recent and expected growths or declines of the targeted industries.

- Identify the specific market niche for the proposed technology and describe its size and potential for growth.

- Describe any specific barriers to entry or expansion.

- Describe the commercialization plan for the proposed technology(ies).

- Describe what steps will be followed to gain CARB certification or verification of the proposed technology(ies).

- Describe the strategy for sustainable support after the successful demonstration of the technology. This could include, but is not limited to, special workforce training that will be required for installation and maintenance personnel, component replacement, technical support, and warranty support.

- Describe the economic benefits that a California business could expect if they operated zero- or near zero-emission equipment that is part of this demonstration.

11. Application Completeness – 5 points

- Applications that are clear, concise, and include all of the requested information will be scored higher than those that are unclear or missing information. Do not make a declaration as to application completeness in your submittal.

- Provide a written affirmation in the Project Narrative that all parties participating in the demonstration have read and agree to abide by the Sample Grant Agreement that is included in this Solicitation packet as Appendix B, and confirm that they are committing to fulfill obligations detailed in the application package.

- One point is provided for sending CARB an email notification of a submitted application, as described in Section XIII, Application Instructions.

XVI. GRANTEE SELECTION

The successful Grantee will be required to sign a Grant Agreement with CARB to fulfill the administrative duties and technical duties associated with the project (see Appendix B, Sample Grant Agreement). Signed Grant Agreements and approved governing board resolutions must be returned to CARB no later than the deadline described in the Solicitation Timeline in Section XIII of this Solicitation. If project Grant Agreements and approved governing board resolutions are not returned by the deadline, CARB, in its sole discretion, may deny the grant application and can redirect funds to another submitted application to this Solicitation or to another project in the Funding Plan as needed. If, in CARB's sole discretion, no submitted application meets the goals of this Solicitation, Funding Plan, or AQIP Guidelines, no selection of a Grantee or technology manufacturer will be made, and funding can be directed to another project identified in the Funding Plan as needed.

The Grant Agreement may not be executed unless and until any required CEQA review has been completed. For a project where an agency other than CARB is serving as lead CEQA agency, the applicant must submit any required final CEQA documents by November 17, 2017 (prior to execution of the Grant Agreement). If an applicant fails to meet this requirement, CARB may deny the grant application. CARB will independently review any CEQA documentation provided by the applicant. CARB may modify any Grant Agreement based upon information produced from the CEQA environmental review process. If CARB in its sole discretion finds a project's CEQA documentation inadequate, CARB retains absolute sole discretion to either (1) modify the grant agreement as necessary to comply with CEQA, (2) select other feasible alternatives to avoid significant environmental impacts, or (3) deny the grant application. No legal obligations will exist unless and until the parties have executed and delivered a mutually acceptable Grant Agreement, as informed by information produced from the CEQA environmental review process (to the extent applicable). See Appendix E for additional information.

CARB, in its sole discretion, may make minor changes to proposed milestones, work plan, or disbursement schedules in consultation with the applicant, for inclusion in the Grant Agreement.

NOTE: All CEQA requirements must be completed by November 17, 2017 and sub-agreements with all project partners must be executed by January 12, 2017.

XVII. IMPLEMENTATION PROCESS

Meetings

Before work begins, a kick-off meeting will be held in El Monte or Sacramento between the Grantee, the technology manufacturer(s), third-party data analysis provider, and CARB project management staff. The purpose of this meeting will be to discuss the work plan, details of task performance, the project schedule, any changes to the project team, and any issues that may need resolution before CARB-funded work begins. Project update meetings to discuss the project's progress will be held as often as needed, but typically monthly. These meetings can occur via telephone conference calls upon approval of the CARB Project Liaison. Scheduling project update meetings and preparing agendas are the responsibility of the Grantee. Project update meetings need to contain, but are not limited to:

- Agenda for the meeting with conference call information;
- Update of the status of the project;
- Discussion of any difficulties encountered since the last project update meeting;
- Discussion on any deliverables nearing a due date;
- Notification of any pending disbursement requests; and
- Scheduling of the next project update meeting.

Site visits by CARB staff may be required at CARB's sole discretion. A final meeting, or conference call pending CARB Project Liaison approval, will be held at the conclusion of the project to review the results and discuss the status of commercialization plans.

Project Funding Procedure

In order to receive a disbursement, the Grantee must submit a grant disbursement request to CARB. The Grant Disbursement Request Form (see Appendix B, Exhibit C) must be signed by the party authorized and designated in the Grant Agreement and must include all information to substantiate the eligibility of costs to be reimbursed. GGRF grant funds will only be issued for vehicles, equipment, infrastructure, and associated services that are identified in the Project Narrative and Work Plan in the application package, memorialized in the signed Grant Agreement, and that have already been delivered. A detailed invoice will be required. A Progress Report on the status of the project to date, including the milestones for which the disbursement request is requesting reimbursement, is required with all disbursement requests. The advance of grant funds will not be allowed. All disbursements, including administration and project funding, are made on a reimbursement basis after expenses are incurred by the grantee or other project partners.

Disbursements will be made following the procedure described in the Reporting and Monitoring Requirements subsection of this Solicitation and the signed Grant Agreement.

The Application package including the Budget submitted by an Applicant, if selected for funding, will be incorporated by reference as part of the Grant Agreement. Costs associated with administration detailed in the Application must consider the timeframe of the proposed project and may cover an increase in costs that take into account inflation or planned cost of living increases. The application submitted will be the actual costs for the project and will not be amended due to faulty estimations by the applicant, increases in costs due to inflation, or other reasons that have not been covered in the proposed budget.

Reporting and Monitoring Requirements

The Grantee must submit numbered status reports accompanying grant disbursement requests to CARB at least every three months, but may submit on a monthly basis if necessary for more frequent invoicing with prior approval from CARB. These reports must be approved by CARB and must contain the following information, at a minimum, in either Microsoft Word or PDF, as a single electronic file:

- Project Status Report number, title of project, name of Grantee, date of submission, and project grant number;
- Summary of work completed since the last progress report, noting progress toward completion of tasks and milestones identified in the work plan;
- Statement of work expected to be completed by the next progress report;
- Notification of problems encountered and an assessment of their effects on the project’s outcome;
- Data collected from equipment since the last data reporting, as deemed necessary by CARB or its designated third-party data analysis provider;
- Itemized invoice showing all costs for which reimbursement is being requested; and
- Discussion of the project’s adherence to the project timeline.

A final report is required at the end of the project and must include:

- A description of the project’s goals and objectives, methods, results of the demonstration, and future application of the technology; and
- An update on the commercialization prospects.

Final reports will be made public and posted on CARB’s AQIP website.

Requests for additional information may be required by CARB, in its sole discretion, to evaluate reports and to determine if a monthly, quarterly, or final report is complete.

If the Grantee plans on pursuing official verification or certification of the emission reducing potential for its proposed technology, the Grantee must submit documentation in support of that verification or certification to CARB's Project Liaison. Any supporting documentation sent to CARB, U.S. EPA, or any other government agency granting certification or verification, must be concurrently submitted to the Project Liaison assigned to the project, as identified in the Grant Agreement (see Appendix B).

Any change in the project budget, redefining of deliverables, or extension of the project schedule must be approved in advance and in writing by the CARB Project Liaison and may require a Grant Agreement amendment. Once a grant is in place, minor changes to the work to be done or other project scope changes may be considered by CARB, in consultation with the Grantee or technology manufacturer(s). CARB reserves the right to terminate a Grant Agreement if CARB determines, in its sole discretion, that the objectives cannot be reached or that the Grantee, technology manufacturer(s), or their subcontractors cannot or will not perform the required work in a timely manner, as specified in Exhibit A, Section 7 of the Grant Agreement.

The Grantee and technology manufacturer(s) must allow CARB, the California Department of Finance, the California Bureau of State Audits, or any authorized designee access, during normal business hours, to conduct reviews and fiscal audits or other evaluations. Access includes, but is not limited to, reviewing project records, site visits, interviews, and other evaluations as needed. Project evaluations or site visits may occur unannounced as CARB staff or its designee deem necessary.

XVIII. ADMINISTRATION

A. Cost of Developing Application

The Applicant is responsible for the cost of developing an Application, and this cost cannot be charged to the State. In addition, CARB is not liable for any costs incurred during environmental review or as a result of withdrawing a proposed award or canceling the Solicitation.

B. Errors

If an Applicant discovers any ambiguity, conflict, discrepancy, omission, or other error in the Solicitation, the Applicant shall immediately notify CARB of such error in writing and request modification or clarification of the document. CARB shall not be responsible for failure to correct errors.

C. Immaterial Defect

CARB may waive any immaterial defect or deviation contained in an Applicant's application. CARB's waiver shall in no way modify the Application or excuse the successful Applicant from full compliance.

D. Disposition of Applicant's Documents

On the date that the Grant Agreement is signed, all applications and related material submitted in response to this Solicitation become a part of the property of the State and public record.

E. Applicant's Admonishment

This Solicitation contains the instructions governing the requirements for funding projects submitted by interested Applicants, including the format in which the information is to be submitted, the material to be included, the requirements that must be met to be eligible for consideration, and Applicant responsibilities. Applicants must take the responsibility to carefully read the entire Solicitation, ask appropriate questions in a timely manner, submit the application with all required responses in a complete manner by the required date and time, and make sure that all procedures and requirements of the Solicitation are followed and appropriately addressed.

F. Agreement Requirements

The content of this Solicitation and each grantee application shall be incorporated by reference into the final agreement. See the sample Agreement terms and conditions included in Appendix B of this Solicitation.

CARB reserves the right to negotiate with Applicants to modify the project scope, the level of funding, or both. If CARB is unable to successfully negotiate and execute a funding agreement with an Applicant, CARB, in its sole discretion, reserves the right to withdraw the pending award and fund the next highest ranked eligible project. This does not limit CARB's ability to withdraw a proposed award for other reasons, including for no cause.

G. No Agreement Until Signed

No agreement between CARB and the successful grantee is in effect until the agreement is signed by the grantee and signed by the authorized CARB representative. Costs are only subject to reimbursement by CARB after execution; no costs incurred prior to execution of the agreement are reimbursable using CARB funds.

H. No Modifications to the General Provisions

Because time is of the essence, if an Applicant at any time, including after Preliminary Grantee Selection, attempts to negotiate, or otherwise seeks modification of, the General Conditions (attached as Appendix B, Sample Grant Agreement Section 10), CARB may reject an application or withdraw a proposed award. This does not alter or limit CARB's ability to withdraw a proposed award for other reasons, including failure of a third party agency to complete CEQA review, or for no cause.

I. Payment of Prevailing Wages

All applicants must read and pay particular attention to Appendix B, Sample Grant Agreement Section 10.17, entitled "Prevailing wages and labor compliance." Prevailing wage rates can be significantly higher than non-prevailing wage rates. Failure to pay legally-required prevailing wage rates can result in substantial damages and financial penalties, termination of the grant agreement, disruption of projects, and other complications.

J. Solicitation Cancellation and Amendments

CARB reserves the right to do any of the following:

- Cancel this Solicitation.
- Revise the amount of funds available under this Solicitation.
- Amend this Solicitation as needed.
- Reject any or all Applications received in response to this Solicitation.

APPENDIX A

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS AND THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

APPLICATION

Mobile Source Control Division
California Air Resources Board
June 9, 2017

California Climate Investments
Cap and Trade Dollars at Work

California Environmental Protection Agency
Air Resources Board

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STATE OF CALIFORNIA
California Environmental Protection Agency
AIR RESOURCES BOARD
MSCD/ISB/AQIP_97 (Rev. 08/13)

ADVANCED TECHNOLOGY DEMONSTRATION PROJECT APPLICATION

Please print clearly or type all information on this application.

1. Project: Click here to enter text.			
2. Company Name/Air District/Organization Name/Individual Name: Click here to enter text.			
3. Business Type: Click here to enter text.			
4. Contact Name and Title: Click here to enter text.			
5. Person with Contract Signing Authority (if different from above)/Air Pollution Control Officer (APCO): Click here to enter text.			
6. Mailing Address and Contact Information: Street: Click here to enter text.			
City: Click here to enter text.	State: Click here to enter text.	Zip Code: Click here to enter text.	
Phone: (XXX) XXX-XXX		Fax: (XXX) XXX-XXX	
Email: Click here to enter text.			
☐ I have read and understood the terms and conditions of the Sample Grant Agreement.			

I hereby certify under penalty of perjury that all information provided in this application and any attachments are true and correct.

Printed Name of Responsible Party or APCO: Click here to enter text.	Title: Click here to enter text.
Signature of Responsible Party or APCO:	Date:

Third Party Certification (if applicable)
I have completed the application, in whole or in part, on behalf of the applicant.

Printed Name of Third Party: Click here to enter text.	Title: Click here to enter text.
Signature of Third Party:	Date:
Amount Being Paid for Application Completion in Whole or Part: Click here to enter text.	Source of Funding to Third Party: Click here to enter text.

Attachment 1: PROJECT EXECUTIVE SUMMARY AND PROJECT SUMMARY FOR PUBLIC POSTING

Project Executive Summary
The Project Executive Summary must contain a summary of the proposed project that identifies:

- the name of the applicant,
- the project technology demonstrator(s),
- the project data collection and analysis provider,
- the project title,
- the objectives of the project,
- a description of the project,
- methods to be employed,
- technologies to be demonstrated,
- potential benefits and outcomes,
- major participants,
- total project cost,
- requested funding amount,
- match amounts proposed,
- cost-effectiveness,
- project location, and
- expected emission reductions in criteria, toxic, and GHG.

The rest of the proposal should provide more detail, further describing the information of the Project Executive Summary. Proprietary or sensitive business information must not be included, as applications may be made available to the public. The project summary must not exceed one page when printed using standard 8.5” by 11” paper with a minimum of 1” margins (top, bottom, left, and right) with font not smaller than 11 point.

Project Summary for Public Posting

The Project Summary for Public Posting is required for all competitive applications for Low Carbon Transportation GGRF funds and will be publically posted on CARB's website at least ten days before ARB preliminarily selects applications as Grantees. The Brief Project Summary for Public Posting must be no more than 500 words and must include:

- Project Name;
- Name of applicant and project partners;
- Brief description of proposed project including location (excluding personally identifiable information for any private individuals);
- Amount of funding requested;
- Total cost of project including requested funding amount and match amounts that are proposed;
- Expected emission reductions in criteria, toxic, and GHG; and
- Whether the project is expected to be located within or provide benefits to a disadvantaged community.

Please note that CARB may, in its sole discretion, modify the Project Summary for Public Posting to more accurately present the required project information as it is presented in the actual project application.

Attachment 2: PROJECT NARRATIVE AND WORK PLAN

The project narrative must separately address each of the scoring criteria requiring a response listed in the evaluation and scoring section of the solicitation. The first page of the project narrative must include the project's title, funding amount requested, applicant (public entity or non-profit organization), industry partner(s) that will act as the technology demonstrator(s) (if applicable), and end user(s). Partners are persons or organizations that will contribute resources to the project via cash, equipment/materials, facilities, or in-kind services. The project narrative must not exceed 15 pages when printed using standard 8.5" by 11" paper with a minimum of 1" margins (top, bottom, left and right) with font no smaller than 11 point. Do not include internet addresses (URLs) as a substitute to providing information necessary to review the application. Provide sufficient information so that reviewers will be able to evaluate the application in accordance with these scoring criteria.

The project narrative must contain affirmation that all parties participating in the demonstration have read the Sample Grant Agreement (Appendix B). The project narrative must demonstrate that the proposed project provides benefits to disadvantaged communities, as outlined in the Eligible Projects section of the Solicitation. Include the project's estimated reductions of GHG, criteria pollutant, and toxic air contaminant emissions (with supportive calculations included in Attachment 3). Describe any proposed use of existing infrastructure (e.g., electric vehicle supply equipment, hydrogen refueling stations, etc.) to support advanced technology project vehicles. Declare if the proposed project uses any equipment that has been funded with a public incentive program and state its incentive program status, as described in the Scope of Work section of the Solicitation. The project narrative must include a plan to ensure that emission reductions required by any incentive program's contract or grant are considered for the piece of equipment that is proposed to be used for the technology demonstration. Include a clear explanation of the steps required in the process for legal operations on California roadways, usage on port properties, rail yards, and other sites where on-road project-funded vehicles will be operated. Explain the steps that will be followed to accomplish required government certification and verification protocols where applicable. Both the project narrative and work plan must address how the applicant will implement all of the tasks in the proposed scope of work. Provide bibliographic citations for any references cited, including names of all authors, the article and journal title, book title, volume number, page numbers, and year of publication. Enclose with your application any documents (or pertinent excerpts) that you cite in support of performance claims in your project.

Work Plan
A detailed work plan needs to be included in the application package. The work plan should detail each specific task that is required to complete the demonstration project, as milestones, and the timing of each task that lead to the on-time completion of the demonstration project. Emission testing is a required element and must be included in the work plan.

The work plan should be in a format that shows a logical sequence of tasks with project deliverables easily identifiable. The Grantee and technology demonstrator will make available, at CARB's request, all information and data generated as part of the project that is described in the work plan and scope of work.

Sample Work Plan Format

Task 9. Hybrid School Bus Emission Testing
The purpose of this task is to perform preliminary on-road emission testing on a demonstration hybrid school bus and collect fuel usage data.

Task 9.1 *Hybrid School Bus Company* will install PEMs unit on school bus and verify that the PEMS is operating normally.

Task 9.2 *Hybrid School Bus Company* will calibrate PEMS unit for on-road testing and perform on-road testing and evaluate results.

Task 9.3 *Hybrid School Bus Company* will begin sampling of exhaust emissions and fuel usage using PEMS and on-board ECM.

Task 9.4 *Hybrid School Bus Company* will collect emissions data from PEMS and fuel usage data from engines ECM.

Task 9.5 *Hybrid School Bus Company* will evaluate emissions and fuel usage data and prepare report on emissions and fuel usage to Grantee

Deliverable Description: Emission and Fuel Usage Report
Deliverable Due Date: June 30, 2013

Attachment 3: EMISSION REDUCTIONS AND COST-EFFECTIVENESS CALCULATIONS

The applicant must use the methodology in Appendix D to determine emission reductions and cost-effectiveness of proposed projects and include the calculations and results here. All references and variables used that are not included in Appendix D must be cited and explained. All calculations and assumptions made must be shown clearly and in their entirety. SHOW ALL MATH used in calculations. Inaccurate calculations could result in disqualification.
The GHG emission reductions are to be based on life cycle analysis (well to wheel) and calculated in tons of CO_2 equivalent[1] reduced per year. Combined weighted criteria pollutant and PM emission reductions are to be based on exhaust emissions (tank to wheel) and calculated in tons reduced per year.

Four cost-effectiveness calculations are required as follows:

1. dollars per ton of GHG emissions (in CO_2 equivalent) reduced during the actual proposed project over a 2-year demonstration;
2. dollars per ton of GHG emissions (in CO_2 equivalent) reduced once deployed into the marketplace, one year post proposed demonstration and based on a 10-year vehicle/equipment useful life;
3. dollars per ton of combined criteria pollutant and weighted PM emissions reduced during the actual proposed project over a 2-year demonstration; and
4. dollars per ton of combined criteria pollutant and weighted PM emissions reduced once deployed into the marketplace, one year post proposed demonstration and based on a 10-year vehicle/equipment useful life.

[1] "CO_2 equivalent" means the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas.

Attachment 4: PROPOSED BUDGET, PROJECT MILESTONES AND DISBURSEMENT SCHEDULE

The Proposed Budget must include all proposed labor, material, equipment, and installation costs associated with the project, including:

1. requested administrative funds and description of any applicable commitments of cash or match funding for administrative expenses; and
2. requested project-related funds plus committed cash and in-kind match for:
   a) production and/or provision of project vehicles and equipment; and
   b) site preparation, construction and installation of associated infrastructure needed to support project vehicles and equipment.

The Solicitation has a Grantee cost share requirement of at least 25 percent of the total project cost, of which 10 percent must be cash committed by the project team. Please be as specific as possible when describing cash or in-kind match services (i.e., itemize staff time, equipment, consumables, or other costs that are being committed).

Cash match can include cash contributions to the project by the applicant or project partner; cash contributions from Federal, Local, and private sources; administrative and project-related labor expenses; and equipment, materials, and fuel purchased specifically for the project.

In-kind match refers to materials, equipment, and services provided by project partners and made available to the project (i.e., access to existing hydrogen fueling station, equipment transportation). In-kind match can also include funding from State sources such as AB 118 or GGRF.

The Project Milestones and Disbursement Schedule must follow the format described in Exhibit B Attachment II in the sample Grant Agreement (see Appendix B) and illustrated in the Sample Budget and Sample Project Milestones and Disbursement schedule later in this appendix. Milestones must be linked to specific tasks and deliverables detailed in the Project Scope of Work and Schedule (Exhibit B, Attachment III) and illustrated in the Sample Budget and Sample Project Milestones and Disbursement schedule later in this appendix. All disbursement amounts must be tied to a milestone; however, it is not necessary for every milestone to be paired with a disbursement request.

The following conditions apply to the proposed budget and the Project Milestones and Disbursement Schedule:

1. Administrative expenses, both match and grant funded, must be described as either time-and-materials with detailed labor rates, or described as a work product deliverable (i.e., quarterly report, project management plan, etc.).
2. Any labor rate adjustments must be included in the application budget detail for the entire project term. Labor rates may not be increased at any time from those identified in the application.
3. All project partners must participate in the development of the project budget and the Project Milestones and Disbursement Schedule, and agree to be bound by it for the duration of the project. Any expectation of cost of living increases or

increases in costs due to inflation or other reasons need to be included in the proposed project budget along with rationalization for any increases in proposed project costs. Regardless of any proposed increases in costs due to cost of living, inflation, or other reasons the total amount of funding for a proposed project will not be changed once the grant agreement is executed.

4. **<u>All milestones are expense reimbursements. Expenses must be incurred before payment of grant funding. Purchase orders are not sufficient for reimbursement.</u>**
5. Reimbursement for the final report must be at least 10 percent of the requested administrative budget or $10,000, whichever amount is greater.

Sample Proposed Budget
The Sample Proposed Budget may be copied or recreated as needed.[2,3]

(Numbers are provided for illustrative purposes only. Applicant may modify this sample budget to meet their specific needs. This page may also be edited, or deleted if not used)

TASK 1 – PROJECT ADMINISTRATION					
Direct Labor plus Expenses		Grant	Match Funding		
Position/Classification	Hourly rate	CARB	Cash	In-Kind	Total
Program Manager	$200	$10,000	$2,000		$12,000
Project Manager	$150	$45,000	$15,000		$60,000
Technician	$80	$40,000	$8,000		$48,000
Accountant	$80	$16,000	$3,200		$19,200
Clerical	$60	$24,000	$3,000		$27,000
Labor Subtotal		*$135,000*	*$31,200*		*$166,200*
Direct Costs (non-labor)					
Travel Costs	N/A	$20,000		$20,000	$40,000
Equipment and Supplies	N/A			$5,000	$5,000
Other Direct Costs	N/A	$5,000	$5,000	$5,000	$15,000
Task 1 subtotal		***$160,000***	***$36,200***	***$30,000***	***$226,200***
TASK 2 – TECHNOLOGY DESIGN AND BUILD					
Project Costs[4]	N/A				
Task 2.1-Purchase orders	N/A		$80,000	$20,000	$100,000
Task 2.2-Parts delivered	N/A	$2,000,000			$2,000,000
Task 2.3-Assembly	N/A	$1,500,000	$500,000		$2,000,000
Task 2.4-Test and certify	N/A	$1,000,000		$500,000	$1,500,000
Task 2 subtotal		***$4,500,000***	***$580,000***	***$520,000***	***$5,600,000***
TASK 3 – TECHNOLOGY DEMONSTRATION					
Direct Labor					
Project Manager	$150	$30,000			$30,000
Technician	$80	$40,000			$40,000
Labor subtotal		*$70,000*			*$70,000*
Direct costs-Travel/Supplies		$50,000			$50,000
Project Costs					
Task 3.1-Vehicle operation	$80		$500,000		$500,000
Task 3.2-Data collection	N/A	$200,000	$100,000		$300,000
Task 3		***$320,000***	***$600,000***		***$920,000***
Total All		***$4,980,000***	***$1,216,200***	***$550,000***	***$6,746,200***
			% of total		
Total Grant Request to		$4,980,000	74%		
Administration Portion of		$226,200	4.5%		
Cash Match		$1,216,200	18%		
In-Kind Match		$550,000	8%		

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[2] Hourly rates must include direct labor plus overhead and fringe benefits. Any adjustments to hourly rates that may occur over the term of the project must be detailed in the project budget and explained in the application.
[3] Provide additional detail, as necessary, to show cost break down by task, subtask, and project partner.
[4] Example assumes that Task 2 will be invoiced based on completion of work product deliverables.

Sample Project Milestone and Disbursement Schedule

Milestone	Task Description	Project Funding	
		Project Funds	Administrative Funds
1	Conduct Kick-Off Meeting. Task 1.1[a]	$0	$20,000
2	Status updates and quarterly progress reports. Task 1.2[a]	$0	$150,000
…			
7	Execute purchase orders. Completion of Task 2.1[b]	$0	$0
8.1	Part #1 delivered. Completion of Task 2.2.1[b]	$500,000	$0
8.2	Part #2 delivered. Completion of Task 2.2.2[b]	$700,000	$0
…			
9.1	A, B & C assembled. completion of Task 2.3.1[b]		
9.2	D, E &F assembled. Completion of Task 2.3.2[b]		
…			
10	Vehicle deployment. Task 3.1	$0	$0
11	Data collection. Task 3.2[b]	$200,000	$0
12	Oversight of Tasks 3.1 and 3.2[a]	$120,000	$0
13	Draft Final Project Report: Completion of Task 1.4	$0	$0
14	Final Project Report. Completion of Task 1.5[b]	$	$22,620
Subtotal of Project Funds and Administrative Funds		**$**	**$**
Grant Total Funding Amount		**$**	

a) Indicates that work to be invoiced on a time-and-materials basis but not to exceed the total amount for the specific Milestone.

b) Indicates that disbursement will include the total dollar mount for that Milestone contingent upon completion of a specific task supported with a deliverable (as detailed in the Project Schedule.

Attachment 5: DISADVANTAGED COMMUNITIES ELIGIBILITY DETERMINATION

The table below is from page Volume 2, Appendix 2.A of the Cap-and-Trade Auction Proceeds Guidelines for Agencies that Administer California Climate Investments December 2015[4].

Table 2.A-1 Low Carbon Transportation Projects will achieve GHG reductions through the use of zero and near zero-emission passenger vehicles, buses, trucks, and freight technology. Potential administering agencies: ARB, CalSTA/CTC, Caltrans / Local Transit Agencies
CRITERIA TO EVALUATE PROJECTS *Agencies can also use criteria in other applicable tables.* When selecting projects for a given investment, give priority to those that maximize benefits to disadvantaged communities (e.g., use scoring criteria that favor projects which provide multiple benefits or the most significant benefits).
Step 1 – Located Within. *Evaluate the project to see if it: meets at least one of the following criteria for being located in a disadvantaged community census tract*; provides direct, meaningful, and assured benefits to a disadvantaged community; and meaningfully addresses an important community need**.* Project must meet at least one of the following criteria focused on reducing air pollution for disadvantaged community residents: A. Project provides incentives for vehicles or equipment to those with a physical address in a disadvantaged community***; or B. Project provides incentives for vehicles or equipment that will be domiciled in a disadvantaged community; or C. Project provides incentives for vehicles or equipment that reduce air pollution on fixed routes that are primarily within a disadvantaged community (e.g., freight locomotives) or vehicles that serve transit stations or stops in a disadvantaged community (e.g., zero-emission buses); or D. Project provides greater mobility and increased access to clean transportation for disadvantaged community residents by placing services in a disadvantaged community, including ride-sharing, car-sharing, or other advanced technology mobility options (e.g., neighborhood electric vehicles, vanpooling, shuttles, smartphone application-based ride-sharing services, bikesharing services).

** For maps of disadvantaged community census tracts, refer to:* *[http://www.calepa.ca.gov/EnvJustice/GHGInvest/.](http://www.calepa.ca.gov/EnvJustice/GHGInvest/)*

*** To determine community needs, agencies or applicants can use a variety of approaches such as: looking at the factors in CalEnviroScreen that caused an area to be defined as a disadvantaged community; hosting community meetings to get local*

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[4] https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb-funding-guidelines-for-ca-climate-investments.pdf

input; referring to the list of common needs in Table 2-2; or receiving documentation of community support (e.g., letters or emails).

**** "Those with a physical address in a disadvantaged community" may include individuals as well as businesses, public agencies, nonprofits, and other community institutions.*

Table 2.A-1 Low Carbon Transportation *(continued)* Projects will achieve GHG reductions through the use of zero and near zero-emission passenger vehicles, buses, trucks, and freight technology. Potential administering agencies: ARB, CalSTA / CTC, Caltrans / Local Transit Agencies
Step 2 – Provides Benefits To. *If the project does not meet the above criteria for "located within," evaluate the project to see if it: meets at least one of the following criteria for providing direct, meaningful, and assured benefits to a disadvantaged community; and meaningfully addresses an important community need*.* Project must meet at least one of the following criteria focused on reducing air pollution for disadvantaged community residents: A. Project provides incentives for vehicles or equipment to those with a physical address in a ZIP code that contains a disadvantaged community census tract**; or B. Project provides incentives for freight vehicles or equipment that primarily serve freight hubs (see Table 3) located in a ZIP code that contains a disadvantaged community census tract, as identified in the list provided below; or C. Project provides greater mobility and increased access to clean transportation for disadvantaged community residents by placing services that are accessible by walking within ½ mile of a disadvantaged community, including ride-sharing, car-sharing, or other advanced technology mobility options (e.g., neighborhood electric vehicles, vanpooling, shuttles, bikesharing services).

** To determine community needs, agencies or applicants can use a variety of approaches such as: looking at the factors in CalEnviroScreen that caused an area to be defined as a disadvantaged community; hosting community meetings to get local input; referring to the list of common needs in Table 2-2; or receiving documentation of community support (e.g., letters or emails).*

*** "Those with a physical address in a disadvantaged community" may include individuals as well as businesses, public agencies, nonprofits, and other community institutions. For maps of disadvantaged community census tracts, refer to: http://www.calepa.ca.gov/EnvJustice/GHGInvest/.*

Table 3. “Freight Hubs” located in a ZIP code that contains a disadvantaged community census tract

Seaports:			
• Benicia Long Beach • Los Angeles	• Oakland • Hueneme • Richmond	• San Diego • San Francisco	• Stockton • West Sacramento
Rail Yards - BNSF Railway:			
• Barstow • Commerce/Eastern • Fresno • Hobart	• Richmond • San Bernardino • San Diego	• Sheila • Stockton/ Mariposa • Watson	• Oakland International Gateway (OIG)
Rail Yards – Union Pacific Railroad:			
• Colton • Commerce • City of Industry • East Los Angeles	• Lathrop • Mira Loma • Oakland • Railport-Oakland	• Intermodal Container Transfer Facility (ICTF)/ Dolores	• Los Angeles Transportation Center (LATC)
Air Cargo Airports:			
• Burbank (BUR) • Fresno (FAT) • Orange County (SNA)	• Long Beach (LGB) • Los Angeles (LAX) • Ontario (ONT)	• San Jose (SJC) • Oakland (OAK) • Sacramento (SMF)	• Sacramento Mather (MHR) • San Diego (SAN)
Ports of Entry:			
• Calexico	• Otay Mesa		
Distribution Centers and Warehouses:			
A facility that is located in a ZIP code containing a disadvantaged community and that averages more than 100 heavy-duty truck trips per day or is serviced by a direct rail line, which receives, sorts, processes, temporarily stores, and redistributes inventory (products, goods) to retailers, wholesalers, or consumers. This does not include "big box" discount or warehouse retail stores, or storage facilities offered for rent or lease to the public.			

The examples listed below are from Table 2-2 (page 2-14) of Volume 2 of the *Cap-and- Trade Auction Proceeds Guidelines for Agencies that Administer California Climate Investments,* released September 4, 2015 and include illustrative examples of common economic needs of disadvantaged communities (as identified by community advocates).

1. Create quality jobs and increase family income (e.g., targeted hiring for living wage jobs that provide access to health insurance and retirement benefits with long-term job retention, using project labor agreements with targeted hire commitments, community benefit agreements, community workforce agreements, partnerships with community-based workforce development and job training entities, state-certified community conservation corps, etc.).

2. Increase job readiness and career opportunities (e.g., workforce development programs, on-the-job training, and industry-recognized certifications).

3. Revitalize local economies (e.g., increased use of local businesses) and support California based small businesses.

4. Reduce housing costs (e.g., affordable housing).

5. Reduce transportation costs (e.g., free or reduced cost transit passes) and improve access to public transportation (e.g., new services in under-served urban and rural communities).

6. Reduce energy costs (e.g., weatherization, solar, etc.).

7. Improve transit service levels and reliability on systems/routes that have high use by low-income riders.

8. Bring jobs and housing closer together (e.g., affordable housing in transit-oriented development and in healthy, high-opportunity neighborhoods).

9. Preserve community stability and maintain housing affordability for low-income households (e.g., prioritize projects in jurisdictions with anti-displacement policies in place.).

Attachment 6: PROCEDURES FOR HANDLING CONFIDENTIAL INFORMATION

How CARB Handles Confidential Information

CARB prefers that you do not include confidential information (e.g., trade secrets) in your proposal. However, if you find it necessary to include such information, **clearly label it "Confidential"**, and CARB will protect it as confidential information to the degree allowed by CARB regulations on information disclosure in conformance with State law (see Title 17, California Code of Regulations, section 91000, et seq.). CARB will not disclose data identified by an applicant as confidential, except as required by law. However, because of the legal requirements for disclosure of some kinds of information, applicants are advised that CARB cannot provide an absolute guarantee that all material designated as confidential will not be disclosed to the public. Also, the State cannot accept legal liability for such disclosure. If such restrictions are not acceptable to you, **DO NOT INCLUDE CONFIDENTIAL MATERIAL IN YOUR PROPOSAL**.

Confidentiality Provision

The following statement must be signed and returned to CARB with your application if the application includes confidential information that you want to be protected as trade secrets**.**

* * * ** * * *
The restriction on disclosing this information shall not apply to any information identified by the applicant as confidential that (a) is already known to the public or CARB at the time of disclosure, or (b) is or becomes publicly known through no wrongful or negligent act on the part of the review panel members or CARB.

The applicant further agrees that s/he has read the following confidentiality provision and agrees to its terms and conditions.

It is understood that in the course of carrying out this agreement, CARB may provide Confidential Information to non-CARB reviewers. Each review panel member agrees to use his/her best effort to hold Confidential Information in confidence and shall return it to CARB upon the completion of the agreement.

This obligation shall apply only to Confidential Information that is designated or identified as such in writing by CARB prior to the disclosure thereof. All Confidential Information shall be sent only to the review panel members. Moreover, this obligation shall not apply to any Confidential Information which: (a) is or becomes publicly known through no wrongful or negligent act on the part of the review panel; (b) is already known to the review panel member at the time of disclosure; (c) is independently developed by the review panel member without breach of this agreement; or (d) is generally disclosed to third parties by CARB without similar restrictions on such third parties."

X ______________________________ ______________________________
Applicant's signature Date

Attachment 7: California Environmental Quality Act Worksheet

This attachment must be submitted as part of the application if the project proposal includes proposed infrastructure installation (e.g., electric vehicle supply equipment or hydrogen refueling station). Additional information regarding this requirement is available in Appendix E.

The California Environmental Quality Act (CEQA) (Public Resources Code §§ 21000 et seq.) requires public agencies to identify the significant environmental impacts of their actions and to avoid or mitigate them, if feasible.[5] Under CEQA, an activity that may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment is called a “project” (Public Resources Code § 21065). Agency compliance with CEQA may include preparing a Notice of Exemption or conducting an Initial Study and preparing a Negative Declaration, a Mitigated Negative Declaration, or, if there are significant impacts, an Environmental Impact Report.

The Lead Agency is the public agency that has the greatest responsibility for preparing environmental documents under CEQA, and for carrying out, supervising, or approving a project. Where the grant recipient is a public agency, the Lead Agency is typically the recipient. Where the grant recipient is a private entity, the Lead Agency is the public agency that has greatest responsibility for supervising or approving the project as a whole.[6] When issuing contracts, grants, or loans, the California Air Resources Board (CARB or Board) is typically a “Responsible Agency” under CEQA, which means that it may make its own CEQA findings based on review of the Lead Agency’s environmental documents. If CARB is the only public agency with responsibility for approving the project, then CARB may act as the Lead Agency and prepare its own environmental documents (based on analysis provided by the applicant).

This worksheet will help CARB determine what kind of CEQA review, if any, is necessary, and which agency will be performing that review as a Lead Agency. No project can be selected, nor can any grant be executed, until the Lead Agency has determined that the project is exempt from CEQA requirements, or the CEQA requirements have been satisfied.

[5] To view frequently asked questions and answers about CEQA, please visit http://resources.ca.gov/ceqa/more/faq.html.

[6] 14 CCR §§ 15050, 15051. The Lead Agency typically has general governmental powers (such as a city or county), rather than a single or limited purpose (such as an air pollution control district).

Please answer all questions in the worksheet below as completely as possible. It may also help you to think through the CEQA process necessary for your proposed project. CARB may request additional information in order to clarify responses provided on this worksheet.

1. **What are the physical aspects of the project? (Check all that apply and provide brief description of work, including any size or dimensions of the project).**

Project Aspect	Yes	No	Description of Project Aspect
Construction (including grading, paving, etc.)	☐	☐	
Trenching	☐	☐	
New or replaced pipelines	☐	☐	
Construction of underground facilities	☐	☐	
Modification or conversion of a facility	☐	☐	
New or modified operation of a facility or equipment	☐	☐	
On-road demonstration	☐	☐	
Paper study (including analyses on economics, feedstock availability, workforce availability, etc.)	☐	☐	
Laboratory research	☐	☐	
Temporary or mobile structures (skid-mounted)	☐	☐	
Design/Planning	☐	☐	
Other (describe and add pages as necessary)	☐	☐	

2. **Where is the project located or where will it be located? (Attach additional sheets as necessary.)**

Address	County	Type of Work to Be Completed at Site

3. **Will the project potentially have environmental impacts that trigger CEQA review? (Check a box and explain the answer for each question. Additionally, please provide a complete description of any direct physical changes and reasonably foreseeable indirect changes to the environment that may result from the project. Please provide as much detail as possible. You may provide additional information on supplemental pages as necessary.)**

Question	Yes	No	Don't Know	Explanation
Is the project site environmentally sensitive?	☐	☐	☐	
Is the project site on agricultural land?	☐	☐	☐	
Is the land on which the project would be built previously disturbed?	☐	☐	☐	
Is this project part of a larger project?	☐	☐	☐	
Is there public controversy about the proposed project or larger project?	☐	☐	☐	
Will historic resources or historic buildings be impacted by the project?	☐	☐	☐	
Is the project located on a site the Department of Toxic Substances Control and the Secretary of the Environmental Protection have identified as being affected by hazardous wastes or cleanup problems?	☐	☐	☐	
Will the project generate noise or odors in excess of permitted levels?	☐	☐	☐	
Will the project increase traffic at the site and by what amount?	☐	☐	☐	

Question	Yes	No	Don't Know	Explanation
Is the project expected to result in environmental impacts to any other resource area (e.g., air quality, aesthetics, water quality)? (Add pages as necessary.)	☐	☐	☐	

4. Will the project require discretionary permits or determinations, as listed below?

Type of Permit	No	Modified	New	Approving Agency	Reason for Permit, Summary of Process, and Anticipated Date of Issuance
Air Quality Permit	☐	☐	☐		
Water Quality Permit	☐	☐	☐		
Conditional Use Permit or Variance	☐	☐	☐		
Building Expansion Permit	☐	☐	☐		
Hazardous Waste Permit	☐	☐	☐		
Rezoning	☐	☐	☐		
Authority to Construct	☐	☐	☐		
Other Permits (List types)	☐	☐	☐		

5. Of the agencies listed in #4, have you identified and contacted the public agency who will be the lead CEQA agency on the project?

☐ **Yes**. Provide the name <u>and</u> contact information for the lead agency.

____
____
____
____

☐ **No.** Explain why no contact has been made and/or a proposed process for making contact with the lead agency.

____
____
____
____
____

6. **If you identified an agency with discretionary approval authority over the project (see Item 4 above), has as the public agency prepared environmental documents (e.g., Notice of Exemption, Initial Study/Negative Declaration/Mitigated Negative Declaration, Environmental Impact Report, Notice of Determination) under CEQA for the proposed project?**

☐ **Yes**. Please complete the following and attach the CEQA document to this worksheet. (For "Not a project," the title of the document may be an e-mail, resolution, or letter.)

Type of Environmental Review	**Title of Environmental Document (Attach the document to this form)**	**State Clearinghouse Number**	**Completion Date**	**Planned Completion Date (<u>must be before approval of grant</u>)**
"Not a project" ☐ Email ☐ Letter ☐ Resolution ☐ Other:		N/A		N/A
Exempt (Resolution of public agency or Agenda Item approving Exemption)		N/A		N/A
Exempt (Notice of Exemption)		N/A		
Initial Study				
Negative Declaration				
Mitigated Negative Declaration				
Notice of Preparation				
Environmental Impact Report				
Master Environmental Impact Report				

Notice of Determination				
NEPA Document (Environmental Assessment, Finding of No Significant Impact, and/or Environmental Impact Statement)				

☐ **No**. Explain why no document has been prepared. Propose a process for obtaining lead agency approval and estimated date for that approval (must occur before ARB will approve the grant).

____
____
____
____
____
____

Certification: I certify to the best of my knowledge that the information contained in this worksheet is true and complete. I further certify that I am authorized to complete and sign this form on behalf of the proposing organization.

Name: ____

Title: ____

Signature: ____

Phone Number: ____

Email: ____

Date: ____

Attachment 8: Letters of Commitment

Include letters of commitment from partners, subcontractors, community groups that are part of the project team, etc., as appropriate to complete the application.

Attachment 9: APPLICANT QUALIFICATIONS

1. Qualifications Narrative: Please provide an attachment describing your experience/expertise developing, implementing, or administering similar demonstration projects and working with vehicle and equipment manufacturers, technology providers, and other stakeholders; identify how this background will enable you to efficiently and effectively implement the Off-Road Advanced Technology Demonstration Project. This narrative should not exceed two pages.

2. Staff Information: Include information for each staff member to be involved in developing, implementing, or administering the Off-Road Advanced Technology Demonstration Project. Clearly identify staff proposed for day-to-day project implementation. Attach résumés.

Name:	Hourly rate:
Phone:	Email:
Title:	
Expected duties:	
Name:	Hourly rate:
Phone:	Email:
Title:	
Expected duties:	
Name:	Hourly rate:
Phone:	Email:
Title:	
Expected duties:	

If more room is needed, this page may be copied or recreated.

3. Subcontractor Information: Applicants may partner with other entities. Responsibility for deliverables lies with the primary applicant, and the grant will be awarded only to the primary applicant. Provide the names and information for any and all subcontractors and partners. Attach qualification narratives, résumés, and letters of commitment for individuals listed below. Each letter of commitment must describe the nature of the partner's contribution to the project.

Name:	Hourly rate:
Phone:	Email:
Title:	
Expected duties:	
Name:	Hourly rate:
Phone:	Email:
Title:	
Expected duties:	
Name:	Hourly rate:
Phone:	Email:
Title:	
Expected duties:	

If more room is needed, this page may be copied or recreated.

Attachment 10: CONFLICT OF INTEREST DECLARATION

All applicants must disclose any Conflict of Interest with their ability to fulfill the duties of the Off-Road Advanced Technology Demonstration Program Grantee. Summarize your organization's or any subcontractor's (as identified in Attachment 9 of this application) current, ongoing, or pending direct or indirect interest, which poses an actual, apparent, or potential conflict of interest with your ability to fulfill the duties of the Grantee. These may include but are not limited to financial arrangements with or interest in zero- or near zero-emission technology providers, vehicle manufacturers, or related organizations. CARB may consider the nature and extent of any potential or apparent conflict of interest in evaluating, considering, or scoring the application and may disqualify the applicant at CARB's sole discretion.

Attachment 11: STD. 204 PAYEE DATA RECORD

Please fill out and submit as a part of this application the STD. 204 Payee Data Record:

http://www.dhcs.ca.gov/services/Documents/DHCS_STD.204.pdf
This form is required, even if the applicant is a governmental entity. Applications that do not include this completed form will not be scored.

APPENDIX B

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS AND THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

SAMPLE GRANT AGREEMENT

Mobile Source Control Division
California Air Resources Board
June 9, 2017

California Climate Investments
Cap and Trade Dollars at Work

California Environmental Protection Agency
Air Resources Board

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EXHIBIT A

GRANT PROVISIONS

The undersigned parties agree to comply with the requirements and conditions contained herein, as well as all commitments identified in the Grant Solicitation Air Quality Improvement Program and Low Carbon Transportation Greenhouse Gas Reduction Fund Investments: Off-Road Advanced Technology Demonstration Project (Exhibit C) and Grantee Application Package (Exhibit D).

1. LOGO AND NAME

The California Climate Investments logo and name serves to bring under a single brand the many investments whose funding comes from the Greenhouse Gas Reduction Fund (GGRF). The logo represents a consolidated and coordinated initiative by the State to address climate change by reducing greenhouse gases, while also investing in disadvantaged communities and achieving many other co-benefits. The Grantee agrees to acknowledge the California Climate Investments program as a funding source from CARB's Low Carbon Transportation program whenever projects funded, in whole or in part by this Agreement, are publicized in any news media, websites, brochures, publications, audiovisuals, or other types of promotional material. The acknowledgement must read as follows: 'This publication (or project) was supported by the "California Climate Investments" (CCI) program. Guidelines for the usage of the CCI logo can be found at www.arb.ca.gov/ccifundingguidelines

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

2. GRANT SUMMARY AND AMENDMENTS (IF APPLICABLE)

Project Title: Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program: Off-Road Advanced Technology Demonstration Projects:

Funding Amount: $

Match Amount: $

3. GRANT PARTIES AND CONTACT INFORMATION

3.1 This grant is from the California Air Resources Board (hereinafter referred to as (CARB) to the ___________________________________ (hereinafter referred to as Grantee).

3.2 The CARB Project Liaison is Nathan Dean. Correspondence regarding this project must be directed to:

Nathan Dean
California Air Resources Board
Mobile Source Control Division
9480 Telstar Avenue No. 4
El Monte, California 91731
Phone: (626) 575-6998
E-mail: Nathan.dean@arb.ca.gov

3.3 The Grantee Liaison is____________________. Correspondence regarding this project must be directed to:

Grantee Liaison:
Title:
Address:
Phone:
Email:

4. TIME PERIOD

4.1 Performance of work or other expenses billable to CARB under this grant may commence after signing and awarding of this grant. Performance on this grant ends once the Grantee has submitted the final report or if the grant is terminated, whichever is earlier.

4.2 Upon completion of the project, the Grantee must submit a draft final report to the Project Liaison no later than **February 14, 2020** (see Section 9.4).

4.3 Final report and final request for payment must be received by CARB no later than **March 30, 2020** (see Section 7.6).

4.4 The CARB's Executive Officer retains the authority to terminate or reduce the dollar amount of this grant if by **January 1, 2019**, 45 percent of project funding, and also by **January 1, 2020**, 75 percent of project funding, has not been expended by the Grantee. In the event of such termination, Section 10 of these provisions apply.

5. SCOPE OF WORK

5.1 Description

5.1.1 The Grantee will demonstrate off-road advanced technology equipment in the following locations

____

5.1.2 Additional Scope of Work detail is in Exhibit B Work Statement and Exhibit D Grantee Application Package, Attachment 2.

5.2 General responsibilities.

5.2.1 CARB is responsible for the following:

a. Participation in regular meetings with Grantee to discuss project refinements and guide the administration of the project.
b. Reviewing and approving project elements provided by Grantee, such as fueling infrastructure permitting, infrastructure design and construction, general vehicle and equipment design criteria, data collection and analysis.
c. Review and approve all grant disbursement requests (Form MSCD/ISB-90).
d. Provide project oversight in conjunction with Grantee.
e. Ensure compliance with applicable requirements of:
    i. Fiscal Year 2016-2017 Funding Plan for the Air Quality Improvement Program and Low Carbon Transportation Greenhouse Gas Reduction Fund Investments (FY 2016-17 Funding Plan)
    ii. Grant Solicitation Off-Road Advanced Technology Demonstration Project
f. Maintaining adherence to the project timeline.

5.2.2 Grantee's responsibilities include all CEQA requirements, project development, project administration, project reporting, including the following tasks:

a. All CEQA requirements, including but not limited to necessary permits and environmental documents, must be completed prior to the execution of the grant agreement. Ensure the fulfilling of CEQA requirements, this includes ensuring that all necessary permits and environmental documents are prepared and that clearances are obtained from the appropriate agencies.

b. Grantee's key project personnel will participate in an initial Project Kick-Off meeting with CARB staff before work on the project begins. The purpose of the initial meeting will be to discuss the overall plan, details for performing the tasks, the project schedule, and any issues that may need to be addressed. Grantee's key personnel and data collector will also participate in review meetings to discuss progress to be held at least quarterly beginning three months after the initial Project Kick-Off meeting. Additional meetings may be scheduled at the sole discretion of the CARB Project Liaison.

c. Regular project update meetings, to be held at least quarterly, more frequent meetings may be scheduled at the sole discretion of the CARB Project Liaison.
   i. Regular Project Meetings will have an Agenda with call-in information for all participants.
      1. Agenda will detail all the issues to be discussed during the Regular Project Update Meeting
   ii. Agenda will detail items that may cause the project to slip on the time schedule
   iii. The Regular Project Update Meetings will cover the project timeline and steps needed to maintain the project timeline.
   iv. The Regular Project Update Meetings will have discussion on what milestones and workplan tasks are expected to be completed before the next Regular Project Update Meeting.

d. The Grantee must submit numbered status reports accompanying grant disbursement requests to CARB at least every three months, but may submit on a monthly basis if necessary for more frequent invoicing with prior approval from CARB. These reports must be approved by CARB and must contain the following information, at a minimum, in either Microsoft Word or PDF, as a single electronic file:

   i. Project Status Report number, title of project, name of Grantee, date of submission, and project grant number.
   ii. Summary of work completed since the last progress report, noting progress toward completion of tasks and milestones identified in the work plan.
   iii. Statement of work expected to be completed by the next progress report.
   iv. Notification of problems encountered and an assessment of their effects on the project's outcome.
   v. Data collected from vehicles and equipment since the last data reporting.
      1. Grantee must ensure that fleets and manufacturers are flexible for the scheduling of the data logging installation, data retrieval and PEMS testing, if applicable.
   vi. Itemized invoice showing all costs for which reimbursement is being requested.
   vii. Discussion of the project's adherence to the project timeline.

e. Ensure the purchase of advanced technology equipment.

f. Review and approve with consultation with CARB Electric Vehicle Supply Equipment (EVSE) or hydrogen refueling infrastructure design with end-user fleets.

g. Ensure all work plan milestones are met including.
   i. Activating and testing charging stations and or refueling stations, making necessary adjustments.
   ii. Training personnel and provide appropriate educational resources for utilizing charging stations and collecting data.

h. A draft report shall be provided to CARB for comments at least one month before the due date of the final report.
i. Ensure that end-user fleets are working with data collection provider.

6. FISCAL ADMINISTRATION

Budget

6.1 The maximum amount of this grant is $___________. Under no circumstance will CARB reimburse the Grantee for more than this amount.

6.2 The budget for this project is shown in Exhibit B, Attachment I.

6.3 The project will include a cash-match and an in-kind match from private, eligible state, and local funding to leverage the Air Resources Board Investment, for a total project budget of $__________________

6.4 The total funding may only be reallocated in the event that the Grantee requests less administrative funding than the amount stated in the budget.

6.5 The Application package is incorporated by reference as part of the Grant Agreement. Costs associated with administration, detailed in the Application must consider the time frame of the project and may cover an increase in costs that take into account inflation or planned cost of living increases. The application submitted will be the actual costs for the project and will not be amended due to faulty estimations, increases in costs due to inflation or other reasons that have not been covered in the budget.

6.6 Earned Interest

6.6.1 Earned interest means any interest earnings generated from grant funds held by Grantee in interest-bearing accounts.

a. Project funds are not required to be held in an interest bearing account. However, if interest is earned by Grantee on the project the earnings must be reported to CARB. All interest income on the Project funds must be reinvested in and used by the Project or returned to

CARB. Interest earned that is reinvested in Project not included as part of the Total Grant Amount from CARB. Grantee is responsible for reporting to CARB all project expenditures funded with interest earned on the Project funds.

b. Grantee must maintain accounting records (e.g., general ledger) that tracks interest earned, expended, or returned on the Project funds, as follows:
   i. The calculation of interest must be based on an average daily balance or some other reasonable and demonstrable method.
   ii. Interest earned must ensure that it is separately identifiable from interest earned on non-Project funds.
   iii. The methodology for calculating earned interest must be consistent with how it is calculated for Grantee's other fiscal programs.
   iv. Earned interest must be fully expended or returned to CARB by completion of the project, submittal of the Final Report, or by **January 31, 2020,** whichever comes first.
   v. Documentation of interest earned on the Project funds and expenditures made on those funds or returned to CARB must be:
      1. Retained for a minimum of three years after it is generated.
      2. Provided to CARB in Status Reports and a Final Report.

Grant Disbursements

6.7 Requests for payment shall be made with the Grant Disbursement Request Form (Form MSCD/ISB-90) and conform to the instructions identified in the Fiscal Year 2016-17 Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program Off-Road Advanced Technology Demonstration Project Solicitation (Solicitation). Grant payments shall be made on a reimbursement basis and only for actual costs incurred by the Grantee and only when the Grantee has submitted a Grant Disbursement Request Form, milestones stipulated in Exhibit B, Attachment II and the instructions found in the Solicitation have been accomplished, documentation of accomplishment has been provided to CARB in the form of the Status Report, and any associated deliverables (if applicable) have been provided to CARB. CARB will have sole discretion to accelerate the timeline for allowable disbursements of administration and project funds identified in Exhibit B, Attachment II (with the exception of the final project administration disbursement), necessary to assure the goals of the project are met.

6.8 Grant payments are subject to CARB's approval of Status Reports and any accompanying deliverables (see Section 9 Reporting). A payment will not be made if the CARB Project Liaison deems that a milestone has not been accomplished or documented, a deliverable meeting specification has not been provided, claimed expenses are not documented, not valid per the budget, or not reasonable, or the Grantee has not met other terms of the grant.

The Chief of the Mobile Source Control Division or designee of CARB may review the Project Liaison's approval or disapproval of a Grant Disbursement Request. No reimbursement will be made for expenses that, in the judgment of the Division Chief of the Mobile Source Control Division, are not reasonable or do not comply with the Grant Agreement.

6.9 The Grantee shall mail completed and signed Grant Disbursement Requests to the Project Liaison.

6.10 CARB retains the right to withhold payment of ten percent of administrative funds until completion of all work and submission of a Final Report to CARB, It is the Grantee's responsibility to submit a Grant Disbursement Request for this final disbursement of funds.

6.11 CARB shall disburse funds in accordance with the California Prompt Payment Act, Government Code, Section 927, et seq.

Oversight and Accountability

6.12 The Grantee shall comply with all oversight responsibilities identified in the Solicitation, Grantee Application Package, and this Grant Agreement.

6.13 CARB or its designee reserves the right to audit at any time during the duration of this grant the Grantee's costs of performing the grant and to refuse payment of any reimbursable costs or expenses that in the opinion of CARB or its designee are unsubstantiated or unverified. The Grantee shall cooperate with CARB or its designee including, but not limited to, promptly providing all information and documents requested, such as all financial records, documents, and other information pertaining to reimbursable costs, and any matching costs and expenses.

6.14 CARB or its designee may recoup funds which were received based upon misinformation or fraud, or for which a Grantee, manufacturer (including equipment manufacturer), technology provider, or vehicle purchaser is in significant or continual non-compliance with the terms of this grant or State law. CARB also reserves the right to prohibit any entity from participating in Off-Road Advanced Technology Demonstration Project, due to non-compliance with project requirements.

7. PROJECT MONITORING

Meetings

7.1 Kick-Off meeting: A meeting will be held between key project personnel and CARB staff before work on the project begins. The purpose of the first meeting will be to discuss the overall plan, details of performing the tasks, the project schedule, and any issues that may need to be resolved.

Review meetings: Meetings to discuss progress must be held at least quarterly beginning three months after the initial meeting. Additional meetings may be scheduled at the sole discretion of the CARB Project Liaison. Such meetings may be conducted by phone, if deemed appropriate by the CARB Project Liaison.

Technical Monitoring

7.2 Any changes in the scope or schedule for the project shall require the prior written approval of the CARB Project Liaison and may require an amendment to the Grant.

7.3 The Grantee shall notify the CARB Project Liaison in writing, immediately if any circumstances arise (technical, economic, or otherwise), which might place completion of the project in jeopardy. In addition, the Grantee shall also make such notification if there is a change in key project personnel (see Exhibit B, Attachment IV).

7.4 The Grantee shall notify the CARB Project Liaison if the project technology will pursue official verification/certification during the term of this agreement and all documentation in support of the verification/certification must be submitted to the Project Liaison concurrently with the verification/certification submittal.

7.5 In addition to Status Reports (discussed in Section 9 Reporting), the Grantee shall provide information requested by the Project Liaison that is needed to assess progress in completing tasks and meeting the objectives of the project.

7.6 Any change in budget allocations, re-definition of deliverables, or extension of the project schedule must be requested in writing to the CARB Project Liaison and approved by CARB, in its sole discretion, and may require a grant amendment.

8. REPORTING

Status Reports

8.1 The Grantee will submit Status Reports at a minimum of three-month intervals. The Status Reports shall be provided in a format agreed upon between the CARB Project Liaison and the Grantee and meet the requirements of the Solicitation.

8.2 Every Grant Disbursement Request Form (Form Number MSCD/ISB-90) shall be accompanied by a Status Report that documents the completion of a milestone(s) specified in Exhibit B, Attachment II.

8.3 If the project is behind schedule, the Status Reports must contain an explanation of reasons and a detailed explanation of how the Grantee plans to resume the schedule.

Final Report

8.4 When the project is complete, the Grantee shall submit a draft Final Report. The draft Final Report must be submitted to CARB in an appropriate format agreed upon between the CARB Project Liaison and the Grantee. Upon approval of the draft Final Report by the Project Liaison, the Grantee shall provide a written copy of the final version, plus an electronic file.

9. TERMINATION AND SUSPENSION OF PAYMENTS

9.1 CARB reserves the right to terminate this grant upon thirty days' written notice to the Grantee, if CARB determines that the project has not progressed satisfactorily during the previous three months and the Grantee and CARB have been unable to agree on modifications. In case of early termination, the Grantee will submit a Grant Disbursement Request Form, a Status Report covering activities up to, and including, the termination date and following the requirements in Section 9 of these provisions. Upon receipt of the Grant Disbursement Request Form and all Status Reports, a final payment will be made to the Grantee. This payment shall be for all CARB-approved, actually incurred costs that in the opinion of CARB are justified. However, the total amount paid shall not exceed the total grant amount.

9.2 CARB reserves the right to issue a grant suspension order in the event that a dispute should arise. The grant suspension order will be in effect until the dispute has been resolved or the grant has been terminated. If the Grantee chooses to continue work on the project after receiving a grant suspension order, the Grantee will not be reimbursed for any expenditure incurred during the suspension in the event CARB terminates the grant. If CARB rescinds the suspension order and does not terminate the grant, CARB will reimburse the

Grantee for any expenses incurred during the suspension that are reimbursable in accordance with the terms of the grant.

10. CONTINGENCY PROVISION

10.1 In the event this grant is terminated for whatever reason, the CARB Executive Officer or designee reserves the right in his or her sole discretion to award a grant to the next highest scored applicant and if an agreement cannot be reached, to the next applicant(s) until an agreement is reached. If CARB is unable to award a grant under these circumstances, CARB may award a grant to other projects.

11. PROJECT RECORDS

Grantee Record

11.1 As further described below, project records includes but is not limited to Grantee, financial, and other records. All project records must be retained for a period of three (3) years after final payment under this Grant. All project records are subject to audit pursuant to Section 13 of this Grant Agreement. Upon completion of the third year of record retention, the Grantee shall submit all project records to CARB. Hardcopy of electronic records are suitable. Acceptable forms of electric media include hard drives, compact discs, digital video discs and flash drives. Other forms of electronic media may be allowed based on prior written concurrence from CARB.

11.2 The Grantee shall retain a file for the Demonstration Project containing but not limited to:

a. Original executed copy of the Grant Agreement and Grant Agreement Amendments (if applicable).
b. Copies of Grant Disbursement Request Forms.
c. Documentation of earned interest generation and expenditure.
d. All Project Status Report
e. Invoices from project participants for reimbursable items
f. All other information that documents all aspects of the project

Financial Record

11.3 Without limitation of the requirement to maintain project accounts in accordance with generally accepted accounting principles, the Grantee must:

a. Establish an official file for the Demonstration Project, which shall adequately document all significant actions relative to the project.
b. Establish separate accounts, which will adequately and accurately depict all amounts received and expended on the Demonstration Project.

c. Establish separate accounts, which will adequately and accurately depict all income received which is attributable to the Demonstration Project, including cash and in-kind match.

d. Establish an accounting system, which will adequately depict final total costs of the Demonstration Project, including both direct and indirect costs

11.4 Other Records include all deliverables required in Exhibit B, Attachment III, of this Grant Agreement.

12. GENERAL PROVISIONS

12.1 **Amendment:** No amendment or variation of the terms of this Grant Agreement shall be valid unless made in writing, signed by the parties and approved as required. No oral understanding or agreement not incorporated in the Grant Agreement is binding on any of the parties.

12.2 **Assignment:** This grant is not assignable by the Grantee, either in whole or in part, without the consent of CARB in the form of a formal written amendment.

12.3 **Compliance with law, regulations, etc.:** The Grantee agrees that it will, at all times, comply with and require its contractors and subcontractors to comply with all applicable federal and State laws, rules, guidelines, regulations, and requirements.

12.4 **Conflict of interest:** The Grantee certifies that it is in compliance with applicable State and/or federal conflict of interest laws.

12.5 **Disputes:** The Grantee shall continue with the responsibilities under this Grant Agreement during any dispute. Grantee staff or management may work in good faith with CARB staff or management to resolve any disagreements or conflicts arising from implementation of this Grant Agreement. However, any disagreements that cannot be resolved at the management level within 30 days of when the issue is first raised with CARB staff shall be subject to resolution by the CARB Executive Officer, or his designated representative. Nothing contained in this paragraph is intended to limit any rights or remedies that the parties may have under law.

12.6 **Environmental justice:** In the performance of this Grant Agreement, the Grantee shall conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures the fair treatment of people of all races, cultures, and income levels, including minority populations and low-income population of the State.

12.7 **Fiscal management systems and accounting standards:** The Grantee agrees that, at a minimum, its fiscal control and accounting procedures will be sufficient to permit tracing of grant funds to a level of expenditure adequate to establish that such funds have not been used in violation of State law or this

Grant Agreement. Unless otherwise prohibited by State or local law, the Grantee further agrees that it will maintain separate Project accounts in accordance with generally accepted accounting principles.

12.8 **Force majeure:** Neither CARB nor the Grantee shall be liable for or deemed to be in default for any delay or failure in performance under this Grant Agreement or interruption of services resulting, directly or indirectly, from acts of God, enemy or hostile governmental action, civil commotion, strikes, lockouts, labor disputes, fire or other casualty, etc.

12.9 **Governing law and venue:** This grant is governed by and shall be interpreted in accordance with the laws of the State of California, CARB and the Grantee hereby agree that any action arising out of this Grant Agreement shall be filed and maintained in the Superior Court in and for the County of Sacramento, California, or in the United States District Court in and for the Eastern District of California. The Grantee hereby waives any existing sovereign immunity for the purposes of this Grant Agreement.

12.10 **Indemnification:** The Grantee agrees to indemnify, defend and hold harmless the State and the Board and its officers, employees, agents, representatives, and successors-in-interest against any and all liability, loss, and expense, including reasonable attorneys' fees, from any and all claims for injury or damages arising out of the performance by the Grantee, and out of the operation of equipment that is purchased with funds from this Grant Award.

12.11 **Grantee's responsibility for work:** The Grantee shall be responsible for work and for persons or entities engaged in work, including, but not limited to, contractors, subcontractors, suppliers, and providers of services. The Grantee shall be responsible for any and all disputes arising out of its contract for work on the Project, including but not limited to payment disputes with contractors, subcontractors, and providers of services. The State will not mediate disputes between the Grantee and any other entity concerning responsibility for performance of work.

12.12 **Independent actor:** The Grantee, and its agents and employees, if any, in their performance of this Grant Agreement, shall act in an independent capacity and not as officers, employees or agents of CARB.

12.13 **Nondiscrimination**: During the performance of this Grant Agreement, the Grantee and its third party entities shall not unlawfully discriminate, harass, or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, physical disability (including HIV and AIDS), mental disability, medical condition (e.g., cancer), age (over 40), marital status, and denial of family care leave. The Grantee and its third party entities shall insure that the evaluation and treatment of their employees and applicants for employment are free from such discrimination and harassment. The Grantee and its third party entities shall comply with the provisions of the Fair Employment and Housing Act (Gov. Code §12990 (a-f) et seq.) and the applicable regulations promulgated thereunder (California Code of Regulations, Title 2, Section 7285 et seq.). The applicable regulations of the Fair Employment and Housing Commission implementing Government Code Section 12990 (a-f), set forth in Chapter 5 of Division 4 of Title 2 of the California Code of Regulations, are incorporated into this Agreement by reference and made a part hereof as if set forth in full. The Grantee and its third party entities shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement.

The Grantee shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform work under this Grant Agreement

12.14 **No third party rights:** The parties to this Grant Agreement do not create rights in, or grant remedies to, any third party as a beneficiary of this Grant Agreement, or of any duty, covenant, obligation or undertaking establish herein.

12.15 **Prevailing wages and labor compliance:** If applicable, the Grantee agrees to be bound by all the provisions of State Labor Code Section 1771 regarding prevailing wages. If applicable, the Grantee shall monitor all agreements subject to reimbursement from this Grant Agreement to ensure that the prevailing wage provisions of State Labor Code Section 1771 are being met.

12.16 **Professionals:** For projects involving installation or construction services, the Grantee agrees that only licensed professionals will be used to perform services under this Grant Agreement where such services are called for and licensed professionals are required for those services under State law.

12.17 **Severability:** If a court of competent jurisdiction holds any provision of this Grant Agreement to be illegal, unenforceable or invalid in whole or in part for any reason, the validity and enforceability of the remaining provisions, or portions of those provisions, will not be affected.

12.18 **Termination:** CARB may terminate this Grant Agreement by written notice at any time prior to completion of projects funded by this Grant Agreement, upon violation by the Grantee of any material provision after such violation has been called to the attention of the Grantee and after failure of the Grantee to bring itself into compliance with the provisions of this Grant Agreement.

12.19 **Timeliness:** Time is of the essence in this Grant Agreement. Grantee shall proceed with and complete the Project in an expeditious manner.

12.20 **Waiver of Rights:** Any waiver of rights with respect to a default or other matter arising under the Grant Agreement at any time by either party shall not be considered a waiver of rights with respect to any other default or matter. Any rights and remedies of the State provided for in this Grant Agreement are in addition to any other rights and remedies provided by law.

12.21 **Availability of funds:** CARB's obligations under this Grant Agreement are contingent upon the availability of funds. In the event funds are not available, the State shall have no liability to pay any funds whatsoever to the Grantee or to furnish any other considerations under this Grant Agreement.

12.22 **Ownership:** All information or data received or generated by the Grantee under this agreement shall become the property of CARB. No information or data received or generated under this agreement shall be released without CARB's approval. Notwithstanding the above, in the event Grantee is required by deposition, interrogatory, subpoena, or request for documents under the Public Records Act to disclose information or data received or generated under this agreement, Grantee shall provide CARB a prompt written notice prior to disclosure.

12.23 **Audit:** Grantee agrees that CARB, the Department of General Services, Department of Finance, the Bureau of State Audits, or their designated representative shall have the right to review and to copy any records and supporting documentation pertaining to the performance of this Grant and all State funds received. Grantee agrees to maintain such records for possible audit for a minimum of three (3) years after the term of this Grant is completed, unless a longer period of records retention is stipulated. Grantee agrees to allow the auditor(s) access to such records during normal business hours and to allow interviews of any employees who might reasonably have information related to such records. Further, Grantee agrees to include similar right of the State to audit records and interview staff in any subgrant or subcontract related to performance of this Agreement.

EXHIBIT B

Work Statement

Budget Summary (Attachment I)
Project Milestones and Disbursement Schedule (Attachment II)
Project Schedule (Attachment III)
Key Project Personnel (Attachment IV)

EXHIBIT B, Attachment I

Budget Summary

Grantee: **Grant No.:**

Project:

Total Costs & Funding

Costs	Grant	Applicant Match Funding		Total
	Cash	Cash	In-Kind	
1. Demonstration Technology Funds	$	$	$	$
2. Administrative Funds[1]	$	$	$	$
Total	$	$	$	$

Disbursement of Funds:

Demonstration Technology Funding
The Grantee shall receive funds in accordance with the Fiscal Year 2016-17 Low Carbon Transportation GGRF Investments: Off-Road Advanced Technology Demonstration Project.

Project Administration
The Grantee shall receive project administration funding in accordance with the Fiscal Year 2016-17 Low Carbon Transportation GGRF Investments: Off-Road Advanced Technology Demonstration Project.

Project Milestones and Disbursement Schedule

Grantee: **Grant No.:**

Project:

Milestone	**Task Description**	**Project Funding**	
		Project Funds	Administrative Funds
1.3	Execute Grant Agreement, District Resolution	$	$
2.3	Conduct Kick-Off Meeting	$	$
Subtotal of Project Funds and Administrative Funds		**$**	**$**
Grant Total Funding Amount		**$**	

EXHIBIT B, Attachment III

Project Schedule

Grantee: **Grant No.:**

Project:

Detailed Scope of Work and Schedule

Work Task	**Start Date**	**Completion Date**
Task 1 –		
Task 2 –		
Task 3 –		
Task 4 –		
Task 5 –		

EXHIBIT B, Attachment IV

Key Project Personnel

Grantee: **Grant No.:**

Project:

Name	Position	Duties

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EXHIBIT C

2016-2017 GRANT SOLICITATION

Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program

Off-Road Advanced Technology Demonstration Projects

Mobile Source Control Division
California Air Resources Board
June 9, 2017

California Climate Investments
Cap and Trade Dollars at Work

California Environmental Protection Agency
Air Resources Board

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EXHIBIT D

GRANTEE APPLICATION PACKAGE

APPENDIX C

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS AND THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

<u>HYDROGEN REFUELING STATION REQUIREMENTS</u>

Mobile Source Control Division
California Air Resources Board
June 9, 2017

California Environmental Protection Agency

Air Resources Board

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I. MINIMUM TECHNICAL REQUIREMENTS

To be eligible under this Solicitation, applications that include a hydrogen refueling station to be funded as part of the project must, at a minimum, meet each of the following minimum technical requirements. CARB will only process applications that include hydrogen refueling infrastructure projects where the project is proposed to be sited where similar infrastructure already exists (e.g., installing a hydrogen refueling station at an existing fueling station or a commercial or industrial facility). Applications including the use of an existing hydrogen station for refueling project vehicles must provide assurances that the station can meet all refueling needs of the project vehicles in terms of refueling pressure, vehicle storage vessel capacities, hydrogen quality, safe refueling, and other requirements described herein.

A. Station Access

Access to hydrogen refueling stations funded as part of the project must be limited to vehicles and devices approved by the station owner/operator for use. Applications must describe how station access will be controlled and, if non-project vehicles are granted access for refueling, what steps will be taken to ensure safe refueling.

B. Hydrogen Quality

Hydrogen dispensed at the station shall meet the requirements adopted by the Department of Food and Agriculture Division of Measurement Standards, and found in Title 4, Division 9, Chapter 6, Article 8 of the California Code of Regulations, Automotive Products Specifications. The regulation adopts by reference the Society of Automotive Engineers (SAE) International J2719: 2011, "Hydrogen Fuel Quality for Fuel Cell Vehicles" (www.sae.org). A hydrogen refueling station must undergo and pass the hydrogen purity test under all of the following circumstances: before being considered operational; every 6 months thereafter; and when the hydrogen lines are potentially exposed to contamination due to maintenance or other activity. The applicant must employ and provide a narrative of the best practices that ensure continued adherence to hydrogen purity standards.

C. Fueling Protocols

The station/dispenser(s) shall meet the appropriate SAE International standards for the vehicles or equipment being fueled, including SAE J2601/2, "Fueling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles." The applicant must describe how the fueling protocol and equipment at the station match project vehicle requirements and equipment. Applications that include hydrogen station access by non-project light-duty vehicles and refueling of light-duty passenger vehicles, shall meet SAE Standard J2601, "Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles" (www.sae.org).

D. Fire and Safety Awareness, Prioritization, and Adherence

To the extent practicable and with consideration of local ordinances, applicants should meet the requirements of Chapter 23 of the California Fire Code: Motor Fuel Dispensing Facilities and Repair Garages; and use the National Fire Protection Association (NFPA) 2: Hydrogen Technologies Code: 2011 or most recent edition, http://www.nfpa.org, as a guideline for hydrogen refueling station design.

E. Dispenser Pressure

Each hydrogen refueling station identified for the project shall dispense fuel at 350 bar and follow the appropriate SAE International fueling protocol (e.g., SAE J2601/2).

F. Hydrogen Dispensing

For applications including a hydrogen station that intends to sell hydrogen by the kilogram, the applicant must demonstrate the ability to dispense hydrogen per "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices" as adopted by the 97th National Conference on Weights and Measures 2012, U.S. Department of Commerce, National Institute of Standards and Technology (NIST), Handbook 44: 2013.

Hydrogen dispenser performance specifications must satisfy NIST Handbook 44: 2013, unless superseded by California Department of Agriculture (CDFA), Division of Measurement Standards Rulemaking: California Code of Regulations (CCR) 3.39 "Hydrogen Gas-Measuring Devices -- Tentative Code" (as proposed for replacement through public review processes).

G. Hydrogen Technologies Code

The station/dispenser(s) shall be capable of meeting or exceeding the National Fire Protection Association (NFPA) 2: Hydrogen Technologies Code: 2011 or most recent edition, www.nfpa.org.

H. Station Design Requirements

Hydrogen refueling stations must have a plan in place for continued refueling of project vehicles in the event that the existing station goes off-line. The applicant must provide a detailed plan, equipment list, and performance specifications to show they are able to obtain and contract for temporary fueling from an experienced supplier.

I. Renewable Hydrogen

Applications must demonstrate compliance with the minimum Renewable Hydrogen Requirements (Section II of this Appendix). This compliance may be met considering all stations included in the application for which the applicant is applying for funding under this Solicitation.

II. RENEWABLE HYDROGEN REQUIREMENTS

Applications that request funding for proposed hydrogen refueling station(s) must provide a plan for ensuring that dispensed hydrogen is generated using at least 33 percent eligible renewable resources (i.e., feedstocks or electricity) as detailed below. This plan must detail the process used to generate the hydrogen, the location where the hydrogen will be generated (i.e., at the proposed hydrogen station site or at an off-site production facility), the eligible renewable resources used to generate the hydrogen, and how the applicant will track and provide verifiable evidence that the dispensed hydrogen is generated from at least 33 percent eligible renewable resources.

A. Eligible Renewable Feedstocks

Eligible renewable feedstocks include:

- Biomethane or biogas such as: biomass, digester gas, landfill gas, sewer gas, or municipal solid waste gas.

- Other feedstocks may be eligible if the Application demonstrates that the proposed feedstock is sustainably produced, reduces greenhouse gas emissions compared to the petroleum baseline, and achieves the Sustainability Goals of the Alternative and Renewable Fuel and Vehicle Technology Program Regulations (20 CCR 3101.5).

B. Eligible Renewable Electricity Sources

Eligible renewable electricity sources include facilities that use the following:

- Fuel cells using renewable fuels
- Geothermal
- Small hydroelectric (30 megawatts or less)
- Ocean wave
- Ocean thermal
- Tidal current
- Photovoltaic (PV)
- Solar Thermal
- Wind
- Biomass digester gas
- Municipal solid waste conversion (non-combustion thermal process)
- Landfill gas

C. Required Information

For hydrogen produced directly from eligible renewable feedstocks, applications must include information about the source of the feedstock(s); how the feedstocks will be processed into fuel; and how the fuel will be transported, stored, and ultimately dispensed at the proposed station(s). For hydrogen generated from electricity (e.g., electrolysis), applicants must describe source(s) of eligible renewable electricity that satisfy the conditions outlined below in Appendix C, II, D.

Once a project hydrogen station is operational, the Grantee will be responsible for ensuring that data is provided to CARB on a quarterly basis regarding hydrogen production, delivery, and dispensing for the purposes of carrying out the demonstration. Data collection will include but not be limited to:

- For all stations – performance data including quantity of fuel produced and dispensed, energy used for hydrogen production, storage, cooling, compression, and dispensing, estimated cost to produce fuel, fueling times, station down time, servicing and maintenance information, and driver/operator feedback on refueling.
- For a station generating hydrogen from electrolysis – documentation of electricity and water used for hydrogen generation, power generated from on-site sources and attributed to onsite hydrogen production, and if applicable, power obtained through other eligible sources.
- For a station producing hydrogen from eligible renewable feedstocks – amount of biogas or other renewable feedstock (in mega joules), total amount of fossil natural gas from the pipeline (in mega joules) or other fuel used for hydrogen generation and steam production, and total electricity and water usage for hydrogen generation, storage, compression and dispensing.

All data will be recorded on the NREL Data Collection Tool,[1] or another format as specified by CARB.

D. Renewable Electricity Requirements

Renewable electricity used for hydrogen generation may be:

(1) generated from one or more eligible electricity sources (listed above-Appendix C. II. B) that meet the requirements under California Public Utilities Code section 399.12, and are co-located with the refueling station site or located on property owned by the hydrogen producer, and produce no additional renewable attributes such as renewable energy certificates; or

(2) obtained through a program with eligibility requirements that match or are more stringent than the Green Tariff Shared Renewables program under the California Public Utilities Code sections 2831-2835.

[1] The NREL Data Collection Tool is Attachment 11 of GFO-15-605 – Light Duty Vehicle Hydrogen Refueling Infrastructure located on the California Energy Commissions Contracts webpage. http://www.energy.ca.gov/contracts/GFO-15-605/.

E. Biogas Requirements

Applicants planning to use biogas must describe how they will either produce or purchase biogas (certified as renewable) that will be delivered directly to their hydrogen production facility or injected into a pipeline system. For pipeline-supplied natural gas to be certified as renewable (RNG), the applicant must be prepared to provide contracts and invoices to demonstrate the injection of RNG at its source and the purchase of the associated renewable attributes, and show that an equivalent amount of pipeline natural gas was withdrawn for use by the hydrogen producer.

F. Verification

CARB will verify, based on the information provided in the application, whether the renewable hydrogen requirement is met.

G. SB 1505 Disclaimer

The 33 percent Renewable Hydrogen Content requirement is a condition to participate in this Solicitation. This is separate and distinct from CARB's sole authority to regulate the renewable hydrogen content requirements for hydrogen refueling stations under Health and Safety Code, Section 43869 (commonly referred to as Senate Bill 1505 or SB 1505). Fulfilling the 33 percent Renewable Hydrogen Content requirement in this Solicitation does not guaranty or warranty in any way that hydrogen refueling stations funded under this Solicitation will meet any standards or regulations that CARB may adopt in the future for hydrogen refueling stations pursuant to the authority in SB 1505. The applicant will be solely responsible for complying with such standards and regulations as applicable, including funding its compliance with them.

H. Greenhouse Gas Requirements

Applicants must use the "well-to-wheel" calculation methodology for the greenhouse gas emission calculations that includes the feedstock(s) and energy used to produce hydrogen, the process, combustion and fugitive emissions that occur during production of the hydrogen, and the fuel transport and final use of the hydrogen. See Appendix D for the emission reduction and cost-effectiveness methodology.

APPENDIX D

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS AND THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

METHODOLOGY FOR DETERMINING EMISSION REDUCTIONS AND COST-EFFECTIVENESS

Mobile Source Control Division
California Air Resources Board

June 9, 2017

California Climate Investments
Cap and Trade Dollars at Work

California Environmental Protection Agency
Air Resources Board

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Table of Contents

ABBREVIATIONS

The following abbreviations are used in this appendix:

"AQIP" means the Air Quality Improvement Program.
"ATV" means advanced technology vehicle.
"bhp-hr" means brake-horsepower-hour.
"CARB" means the California Air Resources Board.
"CARBOB" means California Reformulated Gasoline Blendstock for Oxygenate Blending.
"CaRFG" means California reformulated gasoline.
"CI" means carbon intensity.
"CO2e" means carbon dioxide equivalent.
"CNG" means compressed natural gas.
"CRF" means capital recovery factor.
"ED" means fuel energy density.
"EER" means energy economy ratio.
"EF" means emission factor.
"ER" means emission reduction.
"FAME biodiesel" means fatty acid methyl esters biodiesel.
"g/bhp-hr" means grams per brake-horsepower-hour.
"gal" means gallon.
"GHG" means greenhouse gas.
"GVWR" means gross vehicle weight rating.
"HC" means hydrocarbon.
"hp" means horsepower.
"kWh" means kilowatt-hour.
"LNG" means liquefied natural gas.
"LSI" means large spark-ignition.
"MJ" means megajoule.
"NMHC" means non-methane hydrocarbon.
"NOx" means oxides of nitrogen.
"PM" means particulate matter.
"PM10" means particulate matter less than 10 microns in diameter.
"ROG" means reactive organic gases.
"scf" means standard cubic foot.
"ULSD" means ultra-low sulfur diesel.
"WER" means weighted surplus emission reduction.
"yr" means year.

I. OVERVIEW

The methodology below must be used to calculate the emission reductions and cost-effectiveness of projects proposed under this Solicitation. All calculations and assumptions made must be shown clearly and in their entirety in the application (Appendix A, Attachment 3).

All calculations will use the cleanest commercially available diesel-fueled vehicle or piece of equipment, which in many cases will employ a 2017 model year or Tier 4 Final engine, for baseline greenhouse gas (GHG) and criteria pollutant emission calculations. This technique may not adequately capture the emission profiles of all proposed applications; however to ensure all applications are scored on an objective basis, this technique will be used for scoring all submitted applications. Alternate calculation methodologies, in addition to that required above, may be submitted to illustrate the potential emission reductions from the proposed projects.

GHG emission calculations are to be based on life cycle analysis (well-to-wheel). Criteria pollutant and PM emission calculations are to be based on exhaust emissions (tank-to-wheel). The GHG emission factors in Section II, below, are excerpted from the 2015 Low Carbon Fuel Standard (LCFS) regulation.[1] Please note that while the LCFS fuel carbon intensity values may change during the Solicitation period, project applicants must use the values listed in this appendix. The remaining emission factors and methodology below are from Appendices C, D, and G of the California Air Resources Board (CARB or Board) approved 2011 Carl Moyer Program Guidelines (Moyer Guidelines), as updated in 2016.[2] Language has been modified where necessary for the purposes of this Solicitation. The complete Moyer Guidelines, including all of its appendices, can be found at http://www.arb.ca.gov/msprog/moyer/guidelines/current.htm.

Emission factors for engines that meet an optional low oxides-of-nitrogen (NOx) standard are given for the purpose of this Solicitation only and are based on emission factors developed for the FY 2016-17 Air Quality Improvement Program (AQIP) and Low Carbon Transportation (LCT) Investments Funding Plan.

If a proposed project is for an application that uses a baseline diesel engine of 24 horsepower (hp) or lower, for the purpose of this solicitation and to calculate the needed emission reductions and cost-effectiveness, use the relevant tables for a 25 hp baseline diesel engine in the Moyer Guidelines.

Please see the example calculations provided in Section V of this Appendix to better understand how the following formulas and figures used to calculate emission reduction and cost-effectiveness values. Any examples provided herein are for reference only

[1] CARB, 2015; Low Carbon Fuel Standard, https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf.

[2] CARB, 2016; The 2011 Carl Moyer Program Guidelines, https://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/2011cmpgl_20161228.pdf

and do not imply additional demonstration project types or categories, nor do Carl Moyer Program funding amounts limit the amount of funding that may be available for demonstration projects. Criteria pollutant and particulate matter (PM) table numbers are the same as those in the 2017 Moyer Guidelines. While Carl Moyer Program guidelines may change during the Solicitation period, project applicants must use the values listed in this appendix.

II. EMISSION FACTORS FOR GHG

The following emission factors apply when calculating emission reductions and cost-effectiveness and are applied to Off-Road Advanced Technology Demonstration Projects:

Table II-1: Fuel Energy Density[3]

Fuel (units)	***Energy Density***
CARBOB (gal)	119.53 (MJ/gal)
CaRFG (gal)	115.83 (MJ/gal)
Diesel fuel (gal)	134.47 (MJ/gal)
CNG (scf)	1.04 (MJ/scf)
LNG (gal)	78.83 (MJ/gal)
Electricity (KWh)	3.60 (MJ/KWh)
Hydrogen (kg)	120.00 (MJ/kg)
Denatured Ethanol (gal)	81.51 (MJ/gal)
FAME Biodiesel (gal)	126.13 (MJ/gal)
Renewable Diesel (gal)	129.65 (MJ/gal)

Table II-2: Fuel Carbon Intensity Values[4,5]

Fuel	**Pathway Identifier**	**Carbon Intensity Values (gCO_2e/MJ)**
ULSD – based on the average crude oil supplied to California refineries and average California refinery efficiencies	ULSD001	102.01
CaRFG (calculated)	--	98.47
Fossil CNG	CNG400T	78.37
Fossil LNG	LNG401T	94.42
Biomethane CNG	CNG500T	46.42
Biomethane LNG	LNG501T	64.63
Biodiesel – any feedstock	BIOD202T	102.01
Renewable Diesel – any feedstock	RNWD302T	102.01
Ethanol – corn	ETH100T	75.97
Ethanol – any starch or sugar feedstock	ETH103T	98.47
Hydrogen – all sources	HYGN005	88.33
Electricity – California average	ELC001	105.16

[3] CARB, 2015; LCFS Regulation, Table 3: Energy Densities of LCFS Fuels and Blendstocks. https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf
[4] CARB, 2016; LCFS Temporary Pathway Table. https://www.arb.ca.gov/fuels/lcfs/fuelpathways/temporarypathwaytable.htm, accessed [June 8, 2017].
[5] CARB, 2015; LCFS Regulation. https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf

Table II-3: EER Values for Fuels Used in Light-, Medium-, and Heavy-Duty Applications[6]

Fuels Used as a Diesel Replacement for Heavy-Duty and Off-Road Applications	
Fuel/Vehicle Combinations	**EER Value Relative to Diesel**
Diesel Fuel or Biomass Based Diesel Blends	1.0
CNG or LNG/Any Vehicles (Spark-Ignition Engines)	0.9
CNG/LNG /Any Vehicle (Compression-Ignition Engines)	1.0
Electricity / Battery Electric or Plug-in Hybrid Electric Truck	2.7
Electricity / Battery Electric or Plug-in Hybrid Electric Bus	4.2
Electricity / Fixed Guideway, Heavy Rail	4.6
Electricity / Fixed Guideway, Light Rail	3.3
Electricity / Trolley Bus, Cable Car, Street Car	3.1
Electricity/Forklifts or Equipment	3.8
H_2 / Fuel Cell Vehicle	1.9
H_2 / Fuel Cell Forklifts	2.1

Table II-4: Low NOx Engine Emission Values[7]

Low NOx Engine Emission Factors g/gallon diesel consumed			
Low NOx Standard g/bhp-hr	**NOx g/gal**	**ROG g/gal**	**PM g/gal**
0.1	1.7	0.18	0.148
0.05	0.85	0.18	0.148
0.02	0.344	0.18	0.148

Note that Low NOx emission factors have only been established for 0.02 g/bhp-hr as described in the FY 2016-17 AQIP and LCT Investments Funding Plan. NOx emission factors for 0.1 g/bhp-hr and 0.05 g/bhp-hr are extrapolated and only intended for use in applying for funding under this solicitation. Also note that no emission benefit is assumed for reactive organic gases (ROG) and PM from the use of a Low NOx engine.

[6] CARB, 2015; Low Carbon Fuel Standard, Table 4: EER Values for Fuels Used in Light- and Medium-Duty, and Heavy-Duty Applications; https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf
[7] CARB, 2016; Proposed Fiscal Year 2016-17 Funding Plan For Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program; https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_full.pdf

III. GHG EMISSIONS CALCULATIONS[8]: COST-EFFECTIVENESS AND EMISSION REDUCTION FORMULAS

A. Well-to-Wheel GHG Emission Calculations

Formula 1 and Formula 2 are used to calculate the GHG emission factor in grams of carbon dioxide equivalent (CO2e) per year of use. Formula 2 is used to determine the fuel usage of the baseline vehicle or equipment.

Formula 1 calculates the greenhouse gas emission factor (GHG EF) using the carbon intensity (CI) of the fuel, the fuel's energy density, and the annual fuel usage for the technology employed in the vehicle/equipment.

Formula 1: Greenhouse Gas Emission Factor Based on Fuel Usage

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

Where CI is provided in Table II-2 and fuel energy density is provided in Table II-1.

Formula 2: Annual Fuel Usage

Formula 2 should be used to determine the fuel usage for the baseline vehicle or equipment based on hours of operations and/or miles driven and the fuel economy of the baseline vehicle or equipment.

$$Fuel\ Usage\ \left(\frac{gal}{year}\right) = \left(\frac{gal}{mile} or \frac{gal}{hour}\right) * \left(\frac{miles}{day} or \frac{hours}{day}\right) * \left(\frac{days}{year}\right)$$

B. Conversion from Diesel Fuel Usage to Electricity / Hydrogen / CNG Usage

Formula 3 is used to calculate the advanced technology vehicle (ATV) fuel usage based on the diesel usage of the baseline vehicle/equipment calculated from Formula 2.

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[8] GHG emissions are measured in "CO_2 equivalent", which means the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas.

Formula 3:

$$ATV\ Fuel\ Usage\left(\frac{unit}{year}\right) = Baseline\ fuel\ usage * ED_{diesel} * \left(\frac{1}{ED_{replacement\ fuel}}\right) * \left(\frac{1}{EER}\right)$$

Where:

- **ED** is the fuel energy density (see Table II-1: Fuel Energy Density);
- **EER** is the Energy Economy Ratio value for fuels relative to diesel (see Table D-3: EER Values for Fuels Used in Light-, Medium-, and Heavy-Duty Applications); and
- **Unit** is the units associated with the replacement fuel. Electricity usage is in units of kWh, hydrogen is in kg, and CNG is in standard cubic feet (scf).

C. GHG Emission Reduction Calculation

The project's GHG emission reduction value is determined by taking the difference between the GHG emissions of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

Baseline vehicles or equipment are those using the cleanest engines commercially available at the time the application for funding is submitted, which for the purposes of this solicitation is a Tier 4 Final engine, or the cleanest 2017 model year engine if a Tier 4 Final engine is not commercially available.

Formula 4 is used to determine the annual GHG emission reductions (GHG ER_{annual}) associated with the ATV.

Formula 4:

$$Project\ GHG\ ER_{annual}\left(\frac{metric\ tons\ CO2e}{year}\right) = GHG\ EF_{base} - GHG\ EF_{ATV}$$

Where:

- **Project GHG ER_{annual}** is the annual GHG emission reductions that are associated with the proposed project;
- **GHG EF_{base}** is the GHG emission factor associated with the baseline vehicle or equipment that the advanced technology vehicle or equipment is compared against; and
- **GHG ER_{ATV}** is the GHG emission factor that is associated with the proposed advanced technology vehicle.

D. Cost-Effectiveness Calculations for GHG

The cost-effectiveness of a project is determined by dividing the annualized cost of the potential project by the annual emission reductions that will be achieved by the project as shown in Formula 5 below.

Formula 5 is used to determine the cost-effectiveness of the project in dollars per ton of emissions reduced.

Formula 5:

$$Cost\ Effectiveness\left(\frac{\$}{metric\ ton\ CO2e}\right)=\frac{CRF*incremental\ cost}{Project\ GHG\ ER_{annual}}$$

Where, for the purposes of this Solicitation:

- **CRF** is the Capital Recovery Factor;
- **CRF_2 = 0.515** (2-year life)[9];
- **CRF_{10} = 0.111** (10-year life)[10]; and
- **Incremental cost** is the difference between the cost of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

E. Composite Carbon Intensity Calculations

Formula 6 below is used to determine a composite carbon intensity value in the calculations if two of the same fuel types are to be blended for use in the proposed vehicle or equipment. Use values from Table II-2: Fuel Carbon Intensity Values above as inputs into Formula 6.

Formula 6:

$$CI_{composite}=\left(fraction\ of\ total\ fuel*CI_{fuel\ 1}\right)+\left(fraction\ of\ total\ fuel*CI_{fuel\ 2}\right)$$

F. Advanced Technology Efficiency Calculation

Formula 7 should be used to determine the amount of fuel per year necessary to operate an advanced technology vehicle or equipment that provides a percent efficiency improvement. Use results from Formula 2 to determine the annual fuel usage for the baseline vehicle or equipment.

Formula 7:

$$Fuel\ Usage_{ATV}\left(\frac{gal}{year}\right)=\ fuel\ usage*\left(1-\frac{(X*Y\%\ improvement)}{100\%}\right)$$

Where:

[9] CARB, 2016; The 2011 Carl Moyer Program Guidelines Appendix G: Table G-3a. https://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/2011cmp_appg_20151218.pdf

- **X** is the fraction of the time the advanced operational efficiency technology or logistic strategy is enabled and providing emission reductions. If the advanced operational efficiency technology or logistic strategy is always engaged and providing emission reductions assume that X is equal to 1; and
- **Y** is the percentage fuel economy improvement that is gained by having the advanced operational efficiency technology or logistic strategy efficiency improvement over the baseline engine.

IV. CRITERIA POLLUTANT AND PARTICULATE MATTER EMISSIONS CALCULATIONS: COST-EFFECTIVENESS AND EMISSION REDUCTION

Formulas are taken from Appendix C of the 2011 Moyer Guidelines. Other sections of the Moyer Guidelines are referenced as well. Language has been modified where necessary for the purposes of this Solicitation. Tables that contain emission factors and necessary inputs follow at the end of this section. Updates to these tables in the Moyer Guidelines may have been made since the release of this Solicitation. Only use the information included in the tables in this Solicitation for criteria pollutant reduction and cost-effectiveness calculations.

Baseline vehicles or equipment for the purpose of this Solicitation are the cleanest vehicle or equipment commercially available at the time the application for funding is submitted.

A. Calculating Cost-Effectiveness

The cost-effectiveness of a potential project is determined by dividing the annualized cost of the project by the annual weighted surplus emission reductions that will be achieved by the project as shown in Formula 8 below.

Formula 8: Cost-Effectiveness of Weighted Surplus Emission Reductions ($/ton)

$$\textit{Cost-Effectiveness (\$/ton)} = \frac{\textit{Annualized Cost (\$/year)}}{\textit{Annual Weighted Surplus Emission Reductions (tons/year)}}$$

Where Annualized Cost is calculated using Formula 9 and Annual Weighted Surplus Emission Reductions is calculated using Formula 11.

Descriptions on how to calculate annual emission reductions and annualized cost are provided in the following sections.

B. Determining the Annualized Cost

Annualized cost is the amortization of the one-time incentive grant amount for the life of the project to yield an estimated annual cost. The annualized cost is calculated by multiplying the incremental cost by the capital recovery factor (CRF). [NOTE: For the purposes of this calculation, the CRF is 0.111, which assumes a 10-year life.] The resulting annualized cost is used to complete Formula 8 above to determine the cost-effectiveness of surplus emission reductions.

Formula 9: Annualized Cost ($)

*Annualized Cost = CRF * incremental cost ($)*

Where: **CRF_2 = 0.515**, (2 year life)[10];
CRF_{10} = 0.111, (10-year life)[11]; and
Incremental cost is calculated using Formula 10.

C. Calculating the Incremental Cost

Formula 10: Incremental Cost ($)

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

D. Calculating the Annual Weighted Surplus Emission Reductions

Annual weighted surplus emission reductions (WER) are estimated by taking the sum of the project's annual surplus pollutant reductions following Formula 11 below. This will allow projects that reduce one, two, or all three of the covered pollutants to be evaluated. While NOx and ROG emissions are given equal weight, emissions of PM carry a greater weight in the calculation.

Formula 11: Annual Weighted Surplus Emission Reductions (tons/yr)

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

The result of Formula 11 is used to complete Formula 8 to determine the cost-effectiveness of surplus emission reductions.

In order to determine the annual surplus emission reductions by pollutant, emission reduction calculations need to be completed for each pollutant (NOx, ROG, and PM), for the baseline technology and the advanced technology, totaling up to six calculations:

[10] CARB, 2016; The 2011 Carl Moyer Program Guidelines Appendix G: Table G-3a. https://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/2011cmp_appg_20151218.pdf

Baseline Technology	Advanced Technology
1. Annual emissions of NOx	4. Annual emissions of NOx
2. Annual emissions of ROG	5. Annual emissions of ROG
3. Annual emissions of PM	6. Annual emissions of PM

These calculations are completed for each pollutant by multiplying the engine emission factor or converted emission standard by the annual activity level of the technology and by other adjustment factors as specified for the calculation methodologies presented.

E. Calculating Annual Emission Reductions based on Usage

1. Calculating Annual Emission Reductions Based on Hours of Operation

When actual annual hours of equipment operation are the basis for determining emission reductions, use Formula 12 below.

Formula 12: Estimated Annual Emission Reductions Based on Hours of Operation (tons/year)

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * Horsepower * Load Factor * Activity (hrs/yr) * Percent Operation in California * ton/907,200g*

Where the Emission Factor is provided in Table IV-3, IV-4, IV-6, IV-7, IV-9, IV-10, IV-11, IV-12a, IV-12b, IV-14a, IV-14b, IV-15a, or IV-15b; the Converted Emission Standard is provided in Table IV-1 or IV-2; and the Load Factor is provided in Table IV-5, IV-8, or IV-16.

2. Calculating Annual Emissions Based on Fuel Consumption

When annual fuel consumption is used for determining emission reductions, the equipment activity level must be based on annual fuel usage within California provided by the applicant.

A fuel consumption rate factor must be used to convert emissions given in g/bhp-hr to units of grams of emissions per gallon of fuel used (g/gal). The fuel consumption rate factor is a number that combines the effects of engine efficiency and the energy content of the fuel used in that engine into an approximation of the amount of work output by an engine for each unit of fuel consumed. Formulas 13 and 14 below are the formulas for calculating annual emissions based on annual fuel consumed.

Formula 13: Estimated Annual Emissions based on Fuel Consumed using Emission Factors or Converted Emission Standard (tons/yr)

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

Where the fuel consumption rate factor is provided in Table IV-19.

Formula 14: Estimated Annual Emissions based on Fuel using Emission Factors (tons/yr)

Annual Emission Reductions =

*Emission Factor (g/gal) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

F. List of Criteria Pollutant Cost-Effectiveness Formulas

For an easy reference, the necessary formulas to calculate the cost-effectiveness of surplus emission reductions for a project funded through the Carl Moyer Program are provided below.

Formula 8: Cost-Effectiveness of Weighted Surplus Emission Reductions ($/ton):

$$\text{Cost-Effectiveness (\$/ton)} = \frac{\text{Annualized Cost (\$/year)}}{\text{Annual Weighted Surplus Emission Reductions (tons/yr)}}$$

Formula 9: Annualized Cost ($)

*Annualized Cost = CRF * incremental cost ($)*

Formula 10: Incremental Cost ($)

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

Formula 11: Annual Weighted Surplus Emission Reductions

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

Formula 12: Estimated Annual Emission Reductions Based on Hours of Operation (tons/year)

Annual Emission Reductions =

> *Emission Factor or Converted Emission Standard (g/bhp-hr) * Horsepower * Load Factor * Activity (hrs/yr) * Percent Operation in California * ton/907,200g*

Formula 13: Estimated Annual Emissions based on Fuel Consumed using Emission Factors or Converted Emission Standard (tons/yr)

Annual Emission Reductions =

> *Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

Formula 14: Estimated Annual Emissions based on Fuel using Emission Factors (tons/yr)

Annual Emission Reductions =

> *Emission Factor (g/gal) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

G. Tables for Calculating Criteria and Toxic Pollutant Emission Reductions

ON-ROAD TRUCK TABLES

Table IV-1
Diesel Heavy-Duty Engines
Converted Emission Standards for Fuel Based Usage Calculations

EO Certification Standards g/bhp-hr		NOx	ROG[a]	PM10
		g/gal[b][c][d]		
6.0 NOx	0.60 PM10	103.23	5.33	7.992
5.0 NOx	0.25 PM10	86.03	4.44	3.330
5.0 NOx	0.10 PM10	86.03	4.44	1.332
4.0 NOx	0.10 PM10	68.82	3.55	1.332
2.5 NOx + NMHC	0.10 PM10	40.86	2.11	1.332
1.8 NOx + NMHC	0.01 PM10	29.42	1.52	0.148
1.5 NOx + NMHC	0.01 PM10	24.52	1.27	0.148
1.2 NOx + NMHC	0.01 PM10	19.61	1.01	0.148
0.84 NOx + NMHC	0.01 PM10	13.73	0.71	0.148
0.50 NOx	0.01 PM10	8.60	0.44	0.148
0.20 NOX	0.01 PM10	3.44	0.18	0.148

Table IV-2
Alternative Fuel Heavy-Duty Engines
Converted Emission Standards for Fuel Based Usage Calculations

EO Certification Standards g/bhp-hr		NOx	ROG[a]	PM10
		g/gal[b][c][d]		
6.0 NOx	0.60 PM10	111.00	35.14	11.100
5.0 NOx	0.25 PM10	92.50	29.29	4.625
5.0 NOx	0.10 PM10	92.50	29.29	1.850
4.0 NOx	0.10 PM10	74.00	23.43	1.850
2.5 NOx + NMHC	0.10 PM10	37.00	11.71	1.850
1.8 NOx + NMHC	0.01 PM10	26.64	8.43	0.185
1.5 NOx + NMHC	0.01 PM10	22.20	7.03	0.185
1.2 NOx + NMHC	0.01 PM10	17.76	5.62	0.185
0.84 NOx + NMHC	0.01 PM10	12.43	3.94	0.185
0.50 NOx	0.01 PM10	9.25	2.93	0.185
0.20 NOX	0.01 PM10	3.70	1.17	0.185

a - ROG = HC * 1.26639.
b - Fuel based emissions factors were calculated using fuel consumption rate factors from Table IV-19.
c - Fuel based factors are for engines less than 750 horsepower only.
d - Emission standards were converted where appropriate, using the NMHC and NOx fraction default values and the ultra low sulfur diesel fuel correction factors listed in Table D-25 and D-26 of the Moyer Guidelines, respectively.

Table IV-3
Heavy-Duty Vehicles
14,001-33,000 pounds (lbs) Gross Vehicle Weight Rating (GVWR)
Emission Factors for Mileage Based Calculations (g/mile)a

Model Year	Diesel(b)		
	NOx	ROG(c)	PM10
Pre-1987	14.52	0.75	0.695
1987-1990	14.31	0.59	0.755
1991-1993	10.70	0.26	0.409
1994-1997	10.51	0.20	0.226
1998-2002	10.33	0.20	0.249
2003-2006	6.84	0.13	0.157
2007-2009	4.01	0.11	0.017
2007+ (0.21-0.50 g/bhp-hr NOx)(d)	1.73	0.10	0.017
2010+ (0.20 g/bhp-hr NOx or cleaner)	0.74	0.09	0.017

Table IV-4
Heavy-Duty Vehicles
Over 33,000 lbs GVWR
Emission Factors for Mileage Based Calculations (g/mile)[a]

Model Year	Diesel(b)		
	NOx	ROG(c)	PM10
Pre-1987	21.37	1.09	1.247
1987-1990	21.07	0.86	1.355
1991-1993	18.24	0.56	0.562
1994-1997	17.92	0.42	0.365
1998-2002	17.61	0.43	0.403
2003-2006	11.64	0.27	0.254
2007-2009	6.62	0.23	0.028
2007+ (0.21-0.50 g/bhp-hr NOx)(d)	2.88	0.20	0.028
2010+ (0.20 g/bhp-hr NOx or cleaner)	1.27	0.19	0.028

a - EMFAC 2011 Zero-Mile Based Emission Factors.
b - Emission factors reflect the ultra low sulfur diesel fuel correction factors listed in Table D-26 of the Moyer Guidelines.
c - ROG = HC * 1.26639.
d - Use interpolated values assuming 1.2 g/bhp-hr NOx Standards for 2007-2009 Model Year Grouping and 0.2 g/bhp-hr NOx Standards for 2010+ Model Years.

OFF-ROAD PROJECTS AND NON-MOBILE AGRICULTURAL PROJECTS

Table IV-5
Off-Road Diesel Engines Default Load Factors

Category	Equipment Type	Load Factor
Airport Ground Support	Aircraft Tug	0.54
	Air Conditioner	0.75
	Air Start Unit	0.90
	Baggage Tug	0.37
	Belt Loader	0.34
	Bobtail	0.37
	Cargo Loader	0.34
	Cargo Tractor	0.36
	Forklift	0.20
	Ground Power Unit	0.75
	Lift	0.34
	Passenger Stand	0.40
	Service Truck	0.20
	Other GSE	0.34
Agricultural (Mobile, Portable or Stationary)	Agricultural Mowers	0.43
	Agricultural Tractors	0.70
	Balers	0.58
	Combines/Choppers	0.70
	Chippers/Stump Grinders	0.73
	Generator Sets	0.74
	Hydro Power Units	0.48
	Irrigation Pump	0.65
	Shredders	0.40
	Sprayers	0.50
	Swathers	0.55
	Tillers	0.78
	Other Agricultural	0.51
Construction	Air Compressors	0.48
	Bore/Drill Rigs	0.50
	Cement & Mortar Mixers	0.56
	Concrete/Industrial Saws	0.73
	Concrete/Trash Pump	0.74
	Cranes	0.29
	Crawler Tractors	0.43
	Crushing/Process Equipment	0.78
	Excavators	0.38
	Graders	0.41

Table IV-5 (Continued)

Off-Road Diesel Engines Default Load FactorsCategory	Equipment Type	Load Factor
Construction	Off-Highway Tractors	0.44
	Off-Highway Trucks	0.38
	Pavers	0.42
	Other Paving	0.36
	Pressure Washer	0.30
	Rollers	0.38
	Rough Terrain Forklifts	0.40
	Rubber Tired Dozers	0.40
	Rubber Tired Loaders	0.36
	Scrapers	0.48
	Signal Boards	0.78
	Skid Steer Loaders	0.37
	Surfacing Equipment	0.30
	Tractors/Loaders/Backhoes	0.37
	Trenchers	0.50
	Welders	0.45
	Other Construction Equipment	0.42
Industrial	Aerial Lifts	0.31
	Forklifts	0.20
	Sweepers/Scrubbers	0.46
	Other General Industrial	0.34
	Other Material Handling	0.40
Logging	Fellers/Bunchers	0.71
	Skidders	0.74
Oil Drilling	Drill Rig	0.50
	Lift (Drilling)	0.60
	Swivel	0.60
	Workover Rig (Mobile)	0.50
	Other Workover Equipment	0.60
Cargo Handling	Container Handling Equipment	0.59
	Cranes	0.43
	Excavators	0.57
	Forklifts	0.30
	Other Cargo Handling Equipment	0.51
	Sweeper/Scrubber	0.68
	Tractors/Loaders/Backhoes	0.55
	Yard Trucks	0.65
Other	All	0.43

Table IV-6
Uncontrolled Off-Road Diesel Engines
Emission Factors (g/bhp-hr)

Horsepower	Model Year	NOx	ROG	PM10
25 – 49	pre-1988	6.51	2.21	0.547
	1988 +	6.42	2.17	0.547
50 – 119	pre-1988	12.09	1.73	0.605
	1988 +	8.14	1.19	0.497
120+	pre-1970	13.02	1.59	0.554
	1970 – 1979	11.16	1.20	0.396
	1980 – 1987	10.23	1.06	0.396
	1988 +	7.60	0.82	0.274

Table IV-7
Controlled Off-Road Diesel Engines
Emission Factors (g/bhp-hr)[a]

Horsepower	Tier	NOx	ROG	PM10
25-49	1	5.26	1.74	0.480
	2	4.63	0.29	0.280
	4 Interim	4.55	0.12	0.128
	4 Final	2.75	0.12	0.008
50-74	1	6.54	1.19	0.552
	2	4.75	0.23	0.192
	3[(b)]	2.74	0.12	0.192
	4 Interim	2.74	0.12	0.112
	4 Final	2.74	0.12	0.008
75-99	1	6.54	1.19	0.552
	2	4.75	0.23	0.192
	3	2.74	0.12	0.192
	4 Phase-Out	2.74	0.12	0.008
	4 Phase-In/ Alternate NOx	2.14	0.11	0.008
	4 Final	0.26	0.06	0.008
100-174	1	6.54	0.82	0.274
	2	4.17	0.19	0.128
	3	2.32	0.12	0.112
	4 Phase-Out	2.32	0.12	0.008
	4 Phase-In/ Alternate NOx	2.15	0.06	0.008
	4 Final	0.26	0.06	0.008
175-299	1	5.93	0.38	0.108
	2	4.15	0.12	0.088
	3	2.32	0.12	0.088
	4 Phase-Out	2.32	0.12	0.008
	4 Phase-In/ Alternate NOx	1.29	0.08	0.008
	4 Final	0.26	0.06	0.008

Table IV-7 (Continued)
Controlled Off-Road Diesel Engines
Emission Factors (g/bhp-hr)a

Horsepower	Tier	NOx	ROG	PM10
300-750	1	5.93	0.38	0.108
	2	3.79	0.12	0.088
	3	2.32	0.12	0.088
	4 Phase-Out	2.32	0.12	0.008
	4 Phase-In/ Alternate NOx	1.29	0.08	0.008
	4 Final	0.26	0.06	0.008
751+	1	5.93	0.38	0.108
	2	3.79	0.12	0.088
	4 Interim	2.24	0.12	0.048
	4 Final	2.24	0.06	0.016

Note: Engines that are participating in the "Tier 4 Early Introduction Incentive for Engine Manufacturers" program per California Code of Regulations, Title 13, section 2423(b)(6) are eligible for funding provided the engines are certified to the final Tier 4 emission standards. The CARB Executive Order indicates engines certified under this provision. The emission rates for these engines used to determine cost-effectiveness shall be equivalent to the emission factors associated with Tier 3 engines.

For equipment with baseline engines certified under the flexibility provisions per California Code of Regulations, Title 13, section 2423(d), baseline emission rates shall be determined by using the previous applicable emission standard or Tier for that engine model year and horsepower rating. The CARB Executive Order indicates engines certified under this provision.

a - Emission factors were converted using the ultra low sulfur diesel fuel correction factors listed in Table D-27 of the Moyer Guidelines.
b - Alternate compliance option.

LARGE SPARK IGNITION ENGINES (LSI)

Table IV-8
Off-Road LSI Equipment Default Load Factors

Category	Equipment Type	Load Factor
Agriculture (Mobile, Portable or Stationary)	Agricultural Tractors	0.62
	Balers	0.55
	Combines/Choppers	0.74
	Chipper/Stump Grinder	0.78
	Generator Sets	0.68
	Sprayers	0.50
	Swathers	0.52
	Pumps	0.65
	Other Agricultural Equipment	0.55
Airport Ground Support	A/C Tug	0.80
	Baggage Tug	0.55
	Belt Loader	0.50
	Bobtail	0.55
	Cargo Loader	0.50
	Forklift	0.30
	Ground Power Unit	0.75
	Lift	0.50
	Passenger Stand	0.59
	Other GSE	0.50
Construction	Air Compressors	0.56
	Asphalt Pavers	0.66
	Bore/Drill Rigs	0.79
	Concrete/Industrial Saws	0.78
	Concrete/Trash Pump	0.69
	Cranes	0.47
	Gas Compressor	0.85
	Paving Equipment	0.59
	Pressure Washer	0.85
	Rollers	0.62
	Rough Terrain Forklifts	0.63
	Rubber Tired Loaders	0.54
	Skid Steer Loaders	0.58
	Tractors/Loaders/Backhoes	0.48

Table IV-8 (Continued)
Off-Road LSI Equipment Default Load Factors

Category	Equipment Type	Load Factor
Construction	Trenchers	0.66
	Welders	0.51
	Other Construction	0.48
Industrial	Aerial Lifts	0.46
	Forklifts	0.30
	Sweepers/Scrubbers	0.71
	Other Industrial	0.54

Table IV-9
Off-Road LSI Engines
Emission Factors (g/bhp-hr)

Horsepower	Fuel	Model Year	NOx	ROG	PM10
25 – 49	Gasoline	Uncontrolled – pre-2004	8.01	3.81	0.060
		Controlled 2001-2006	1.33	0.72	0.060
		Controlled 2007-2009[a]	0.89	0.48	0.060
		Controlled 2010+	0.27	0.14	0.060
	Alt Fuel	Uncontrolled – pre-2004	13.00	0.90	0.060
		Controlled 2001-2006	1.95	0.09	0.060
		Controlled 2007-2009[a]	1.30	0.06	0.060
		Controlled 2010+	0.39	0.02	0.060
50 – 120	Gasoline	Uncontrolled – pre-2004	11.84	2.66	0.060
		Controlled 2001-2006	1.78	0.26	0.060
		Controlled 2007-2009[a]	1.19	0.18	0.060
		Controlled 2010+	0.36	0.05	0.060
	Alt Fuel	Uncontrolled – pre-2004	10.51	1.02	0.060
		Controlled 2001-2006	1.58	0.11	0.060
		Controlled 2007-2009[a]	1.05	0.07	0.060
		Controlled 2010+	0.32	0.02	0.060
>120	Gasoline	Uncontrolled – pre-2004	12.94	1.63	0.060
		Controlled 2001-2006	1.94	0.16	0.060
		Controlled 2007-2009[a]	1.29	0.11	0.060
		Controlled 2010+	0.39	0.03	0.060
	Alt Fuel	Uncontrolled – pre-2004	10.51	0.90	0.060
		Controlled 2001-2006	1.58	0.09	0.060
		Controlled 2007-2009[a]	1.05	0.06	0.060
		Controlled 2010+	0.32	0.02	0.060

a - Emission factors for federally certified engines used in preempt equipment.

Table IV-10
Emission Factors for Off-Road LSI Engine Retrofits
Verified to Absolute Emission Number (g/bhp-hr)

Manufacturers of LSI retrofit systems may verify to a percent emission reduction or absolute emissions. If a retrofit system is verified to a percent reduction, the emission factors will be that verified percent of the appropriate emissions factors in Table IV-9. If a retrofit system is verified to an absolute emission number, use the following table for the emission factors.

Fuel	Verified Value	NOx	ROG	PM10
Gasoline	3.0 g/bhp-hr	1.78	0.26	0.060
	2.5 g/bhp-hr	1.48	0.22	0.060
	2.0 g/bhp-hr	1.19	0.18	0.060
	1.5 g/bhp-hr	0.89	0.13	0.060
	1.0 g/bhp-hr	0.59	0.09	0.060
	0.6 g/bhp-hr	0.36	0.05	0.060
	0.5 g/bhp-hr	0.30	0.04	0.060
Alt Fuel	3.0 g/bhp-hr	1.58	0.10	0.060
	2.5 g/bhp-hr	1.32	0.09	0.060
	2.0 g/bhp-hr	1.05	0.07	0.060
	1.5 g/bhp-hr	0.79	0.05	0.060
	1.0 g/bhp-hr	0.53	0.03	0.060
	0.6 g/bhp-hr	0.32	0.02	0.060
	0.5 g/bhp-hr	0.26	0.02	0.060

Table IV-11
Off-Road LSI Engines Certified to Optional Standards
Emission Factors (g/bhp-hr)

Horsepower	Fuel	Optional Standard	NOx	ROG	PM10
25-50	Gasoline	1.50	0.67	0.36	0.060
		1.00	0.44	0.24	0.060
		0.60	0.27	0.14	0.060
		0.40	0.18	0.10	0.060
		0.20	0.09	0.05	0.060
		0.10	0.04	0.02	0.060
	Alt Fuel	1.50	0.98	0.05	0.060
		1.00	0.65	0.03	0.060
		0.60	0.39	0.02	0.060
		0.40	0.26	0.01	0.060
		0.20	0.13	0.01	0.060
		0.10	0.07	0.00	0.060
50-120	Gasoline	1.50	0.89	0.13	0.060
		1.00	0.59	0.09	0.060
		0.60	0.36	0.05	0.060
		0.40	0.24	0.04	0.060
		0.20	0.12	0.02	0.060
		0.10	0.06	0.01	0.060
	Alt Fuel	1.50	0.79	0.05	0.060
		1.00	0.53	0.03	0.060
		0.60	0.32	0.02	0.060
		0.40	0.21	0.01	0.060
		0.20	0.11	0.01	0.060
		0.10	0.05	0.00	0.060
>120	Gasoline	1.50	0.97	0.08	0.060
		1.00	0.65	0.05	0.060
		0.60	0.39	0.03	0.060
		0.40	0.26	0.02	0.060
		0.20	0.13	0.01	0.060
		0.10	0.06	0.01	0.060
	Alt Fuel	1.50	0.79	0.05	0.060
		1.00	0.53	0.03	0.060
		0.60	0.32	0.02	0.060
		0.40	0.21	0.01	0.060
		0.20	0.11	0.01	0.060
		0.10	0.05	0.00	0.060

LOCOMOTIVES

Table IV-12a
Locomotive Emission Factors (g/bhp-hr)
Based on 1998 Federal Standards

Engine Model Year	Type	NOx[(a)]	ROG[(b)]	PM10[(a)]
Pre-1973	Line-haul and Passenger	12.22	0.51	0.275
	Switcher	16.36	1.06	0.378
1973-2001 Tier 0	Line-haul and Passenger	8.93	1.05	0.516
	Switcher	13.16	2.21	0.619
2002-2004 Tier 1	Line-haul and Passenger	6.96	0.58	0.387
	Switcher	10.34	1.26	0.464
2005-2011 Tier 2	Line-haul and Passenger	5.17	0.32	0.172
	Switcher	7.61	0.63	0.206

These factors are to be used for the project baseline emissions if the baseline locomotive is certified or required to be certified to the 1998 federal locomotive remanufacture standards and for the reduced emission locomotive if the project locomotive is remanufactured to these 1998 standards. Factors are based upon Regulatory Impact Analysis: Final United States Environmental Protection Agency (U.S. EPA) Locomotive Regulation (2008).
a - NOx and PM10 emission factors have been adjusted by a factor of 0.94 and 0.86, respectively, to account for use of California ultra-low sulfur diesel fuel.
b - ROG = HC * 1.053

Table IV-12b
Locomotive Emission Factors (g/bhp-hr)
Based on 2008 Federal Standards

Engine Model Year	Type	NOx[(a)]	ROG[(b)]	PM10[(a)]
1973-2001 Tier 0+	Line-haul and Passenger	6.96	0.58	0.189
	Switcher	11.09	2.21	0.224
2002-2004 Tier 1+	Line-haul and Passenger	6.96	0.58	0.189
	Switcher	10.34	1.26	0.224
2005-2011 Tier 2+	Line-haul and Passenger	5.17	0.32	0.086
	Switcher	7.61	0.63	0.112
2011-2014 Tier 3	Line-haul and Passenger	5.17	0.32	0.086
	Switcher	4.70	0.63	0.086
2015 Tier 4	Line-haul and Passenger	1.22	0.15	0.026
	Switcher	1.22	0.15	0.026

These factors are to be used for the project baseline emissions if the baseline locomotive is certified or required to be certified to the new (2008) federal locomotive remanufacture standards, and for the reduced emission locomotive if the project locomotive is remanufactured to the new standards or meets Tier 3 standards. Factors are based upon Regulatory Impact Analysis: Final U.S. EPA Locomotive Regulation (2008).
a - NOx and PM10 emission factors have been adjusted by a factor of 0.94 and 0.86, respectively, to account for use of California ultra-low sulfur diesel fuel.
b - ROG = HC * 1.053

Table IV-13
Locomotive Idle-Limiting Device Emission Reduction Factors

Type	Factor
Switchers	0.90
Line-Haul	0.97
Passenger	0.97

Note: Factors based on assumption Idle Limiting Device (ILD) reduces locomotive engine idling by 50 percent. Multiply total baseline emissions by this factor to determine reduced emissions with ILD.

MARINE VESSELS

Table IV-14a
Uncontrolled Harbor Craft Propulsion Engine
Emission Factors (g/bhp-hr)

Horsepower	Model Year	NOx	ROG	PM10
25-50	All	7.57	1.32	0.520
51-120	pre-1997	14.27	1.04	0.575
	1997+	9.70	0.71	0.524
121-250	pre-1971	15.36	0.95	0.527
	1971-1978	14.27	0.79	0.451
	1979-1983	13.17	0.72	0.376
	1984+	12.07	0.68	0.376
251+	pre-1971	15.36	0.91	0.506
	1971-1978	14.27	0.76	0.431
	1979-1983	13.17	0.68	0.363
	1984-1994	12.07	0.65	0.363
251-750	1995+	8.97	0.49	0.260
751+	1995+	12.07	0.60	0.363

Table IV-14b
Controlled Harbor Craft Propulsion Engine
Emission Factors (g/bhp-hr)

Horsepower	Tier	NOx	ROG	PM10
25-50	1	6.93	1.30	0.580
	2	5.04	1.30	0.240
	3	5.04	1.30	0.176
51-120	1	6.93	0.71	0.524
	2	5.04	0.71	0.240
	3	5.04	0.71	0.176
121-175	1	8.97	0.49	0.290
	2	4.84	0.49	0.176
	3	3.60	0.49	0.077
176-750	1	8.97	0.49	0.290
	2	4.84	0.49	0.120
	3	3.87	0.49	0.068
751-1900	1	8.97	0.49	0.290
	2	5.24	0.49	0.160
	3	3.87	0.49	0.068
1901 +	1	8.97	0.49	0.290
	2	5.24	0.49	0.160
	3	4.14	0.49	0.085

Table IV-15a
Uncontrolled Harbor Craft Auxiliary Engine
Emission Factors (g/bhp-hr)

Horsepower	Model Year	NOx	ROG	PM10
25-50	all	6.42	1.58	0.460
51-120	pre-1997	12.09	1.23	0.508
	1997+	8.14	0.85	0.417
121-250	pre-1971	13.02	1.13	0.466
	1971-1978	12.09	0.94	0.399
	1979-1983	11.16	0.86	0.333
	1984-1995	10.23	0.82	0.333
	1996+	7.75	0.59	0.255
251-750	pre-1971	13.02	1.08	0.448
	1971-1978	12.09	0.90	0.381
	1979-1983	11.16	0.81	0.321
	1984-1994	10.23	0.77	0.321
	1995+	7.60	0.58	0.230
751 +	pre-1971	13.02	1.08	0.448
	1971-1978	12.09	0.90	0.381
	1979-1986	11.16	0.81	0.321
	1987-1998	10.23	0.72	0.321
	1999+	7.75	0.58	0.255

Table IV-15b
Controlled Harbor Craft Auxiliary Engine
Emission Factors (g/bhp-hr)

Horsepower	Tier	NOx	ROG	PM10
25-50	1	6.54	1.54	0.511
	2	5.04	1.54	0.240
	3	5.04	1.54	0.176
51-120	1	6.93	0.85	0.464
	2	5.04	0.85	0.240
	3	5.04	0.85	0.176
121-175	1	6.93	0.58	0.255
	2	4.84	0.58	0.176
	3	3.60	0.58	0.077
176-750	1	6.93	0.58	0.255
	2	4.84	0.58	0.120
	3	3.78	0.58	0.068
751-1900	1	6.93	0.58	0.255
	2	5.24	0.58	0.160
	3	3.87	0.58	0.068
1901 +	1	6.93	0.58	0.255
	2	5.24	0.58	0.160
	3	4.14	0.58	0.085

Table IV-16
Harbor Craft Load Factors

Vessel Type	Propulsion Engine	Auxiliary Engine
Charter Fishing	0.52	0.43
Commercial Fishing	0.27	
Ferry/Excursion	0.42	
Pilot	0.51	
Tow	0.68	
Work	0.45	
Other	0.52	
Barge/Dredge	0.45	0.65
Crew & Supply	0.38	0.32
Tug	0.50	0.31

Table IV-17
Shore Power
Default Emission Rates Grams per kilowatt-hour (g/kWh)

Pollutant	Emission Rate
NOx	13.9
ROG	0.49
PM10 (marine gas oil fuel with 0.11- 0.5 % sulfur content)	0.38
PM10 (marine gas oil fuel with <= 0.10 % sulfur content)	0.25

Table IV-18
Shore Power
Default Power Requirements

Ship Category	Ship Size / Type Default Twenty-foot Equivalent Unit (TEU)	Power Requirement (kW)
Container Vessel	<1,000	1,000
	1,000 – 1,999	1,300
	2,000 – 2,999	1,600
	3,000 – 3,999	1,900
	4,000 – 4,999	2,200
	5,000 – 5,999	2,300
	6,000 – 6,999	2,500
	7,000 – 7,999	2,900
	8,000 – 9,999	3,300
	10,000 – 12,000	3,700
Passenger Vessel	No Default Value – Use Actual Power Requirement[(a)]	
Reefer	Break Bulk	1,300
	Fully containerized	3,300

a - The average power requirement for passenger vessels is 7,400 kW (ARB Oceangoing Vessel Survey, 2005).

ALL ENGINES

Table IV-19
Fuel Consumption Rate Factors (bhp-hr/gal)

Category	Horsepower/Application	Fuel Consumption Rate
Non-Mobile Agricultural Engines	ALL	17.5
Locomotive	Line Haul and Passenger (Class I/II)	20.8
	Line Haul and Passenger (Class III)	18.2
	Switcher	15.2
Other	< 750 hp	18.5
	$\geq$ 750 hp	20.8

V. EXAMPLE CALCULATIONS

Example calculations are provided to illustrate all the permutations that staff expects may be included in an application for funding. Example calculations are included for five scenarios providing the values that are needed for a complete application. Those required values are:

- GHG annual emission reductions from each proposed vehicle or piece of equipment;
- Criteria pollutant and toxic air contaminant annual pollutant emission reductions for each proposed vehicle or piece of equipment;
- GHG reduction cost-effectiveness for a two-year life during the time of the proposed project field demonstration;
- GHG reduction cost-effectiveness for a 10-year life, two years after the end of the proposed demonstration project, assuming the technology is commercialized and integrated into the marketplace;
- Criteria pollutant and toxic air contaminant reduction cost-effectiveness for a two-year life during the time of the proposed project field demonstration; and
- Criteria pollutant and toxic air contaminant reduction cost-effectiveness for a 10-year life, two years after the end of the proposed demonstration project, assuming the technology is commercialized and integrated into the marketplace.

GHG emission reductions are calculated on a well-to-wheel basis and the criteria pollutant emission reductions are determined under a tank-to-wheel scenario. The example calculations contained in this appendix are illustrations of:

Battery-Electric Heavy-Lift Forklift

- This example assumes that a heavy-lift forklift will have the same energy requirements as a diesel counterpart and will be used the same number of hours. Electricity to charge the proposed forklift will come from the electrical grid.

Fuel Cell Top Handler

- This example assumes that a fuel cell top handler will have the same energy requirements as a diesel counterpart and will be used the same number of hours. It is assumed that this project will use hydrogen that is SB 1505 compliant and therefore, has a 1/3 renewable component.

Battery-Electric Switch Locomotive with Fuel Cell Range Extender

- This example assumes that a fuel cell switcher locomotive with battery storage will have the same energy requirements as a diesel-electric counterpart and will be used the same number of hours. Further, it is assumed that in this project, continuous power is provided by the fuel cell and peak power requirements are provided by the on-board traction battery. It is assumed that half of the advanced technology vehicle’s energy needs will come from the on-board battery pack and that half of the vehicle’s energy needs will come from the on-board range extending engine.

Hybrid Wheel Loader with Renewable Diesel

- This example assumes that a hybrid wheel loader will have the same energy requirements as a diesel counterpart and will be used the same number of hours. It is assumed that the hybrid system reduces the equipment's fuel consumption by 15% and renewable diesel is used instead of traditional diesel.

Logistic Strategy for Container Movement Technology

- This example assumes that a piece of cargo handling equipment utilizing advanced logistic technology will have the same energy requirements as a diesel counterpart without the logistic technology and will be used the same number of hours. The logistic strategy is only functional while loading and unloading ocean going vessels and therefore, will only be engaged half of the time during the cargo handling equipment's operation.

All of the following examples assume diesel fuel usage by the baseline vehicle or equipment as a basis for the GHG and criteria pollutant emission calculations. This technique may not adequately capture the emission profiles of all proposed applications; however; this technique is used to allow all submitted applications to be scored objectively.

If a proposed project is for an application that uses a baseline diesel engine of 24 hp or lower, for the purpose of this solicitation and to calculate the needed emission reductions and cost-effectiveness, use the relevant tables for a 25 hp baseline diesel engine in the Moyer Guidelines.

Example A: Battery-Electric Heavy-Lift Forklift

Potential GHG emission reductions are determined on a well-to-wheel basis, while criteria pollutant emission reductions are determined using a tank-to-wheel analysis. This example assumes that a heavy-lift forklift will have the same energy requirements as a diesel counterpart and will be used the same number of hours. Electricity to charge the proposed forklift will come from the electrical grid.

Baseline Diesel Forklift:

- Off-Road diesel engine: Tier 4 Final certification, 110 hp
- 19,000 lbs. lift capacity
- Diesel usage: 2 gallons per hour, 3,000 gallons per year
- Operation: 1,500 hours per year
- Forklift cost at demonstration: $40,000
- Forklift cost two years after demonstration: $40,000

Advanced Technology:

- Battery-electric forklift
- Forklift cost at demonstration: $75,000
- Forklift cost two years after demonstration: $65,000

Variables Used in Calculation:

Carbon Intensity

From Table II-2: Fuel Carbon Intensity Values

CI = Carbon Intensity

$CI_{diesel} = \frac{102.01\ g\ CO2e}{MJ}$ Table Pathway Identifier ULSD001

$CI_{electricity} = \frac{105.16\ g\ CO2e}{MJ}$ Table Pathway Identifier ELC001

Energy Density

From Table II-1: Fuel Energy Density

ED = Energy Density

$ED_{diesel} = \frac{134.47\ MJ}{gal\ diesel}$ $ED_{electricity} = \frac{3.60\ MJ}{kWh}$

Energy Efficiency Ratio

From Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications

EER = Energy Efficiency Ratio (unit less)

$EER_{electricity}$ = 3.8

Step 1: Convert the diesel used per year to the amount of electricity needed to do the same work using Formula 3 and the variables identified above.

Formula 3:

$$Replacement\ Fuel\ Usage\left(\frac{unit}{year}\right) = fuel\ usage * ED_{diesel} * \left(\frac{1}{ED_{replacement\ fuel}}\right) * \left(\frac{1}{EER}\right)$$

Where:

- **ED** is the fuel energy density (see Table II-1: Fuel Energy Density);
- **EER** is the Energy Economy Ratio value for fuels relative to diesel (see Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications);
- **Unit** is the units associated with the replacement fuel. Electricity is in terms of kWh, hydrogen is in kg, and CNG is in scf.

$$Replacement\ Fuel\ Usage\left(\frac{unit}{year}\right) = \left(3{,}000\frac{gal\ diesel}{year}\right) * \left(\frac{134.47\ MJ}{1\ gal\ diesel}\right) * \left(\frac{1\ kWh}{3.60\ MJ}\right) * \left(\frac{1}{3.8}\right)$$
$$= 29{,}500\frac{kWh}{year}$$

Step 2: Determine the GHG emissions that are attributed to the baseline diesel-fueled heavy-lift forklift using Formula 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$
$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right)$$
$$* \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{base} = \left(\frac{102.01\ gram\ CO2e}{MJ}\right) * \left(\frac{134.47\ MJ}{gal\ diesel}\right) * \left(\frac{3{,}000\ gal\ diesel}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 41 \frac{metric\ tons\ CO2e}{year}$$

Step 3: Determine the GHG emissions that are attributed to the advanced technology forklift using Formula 1, the result from Step 1 and the variables identified above.

Formula 1:

$$GHG\ EF \left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{ATV} = \left(\frac{105.16\ gram\ CO2e}{MJ}\right) * \left(\frac{3.60\ MJ}{kWh}\right) * \left(\frac{29{,}500\ kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 11 \frac{metric\ tons\ CO2e}{year}$$

Step 4: Determine the GHG emission reductions that are associated with the proposed project using Formula 4, populated by results from Step 2 and Step 3 above to give the GHG emission benefit from the proposed project.

Formula 4:

$$Project\ GHG\ ER_{annual} \left(\frac{metric\ tons\ CO2e}{year}\right) = GHG\ EF_{base} - GHG\ EF_{ATV}$$

Where:

- **GHG ER$_{\mathbf{annual}}$** is the annual GHG emission reductions that are associated with the proposed project;
- **GHG EF$_{\mathbf{base}}$** is the GHG emission factor associated with the base case vehicle or equipment that the advanced technology vehicle or equipment is compared against; and
- **GHG ER$_{\mathbf{ATV}}$** is the GHG emission factor that is associated with the proposed advanced technology vehicle.

$$Project\ GHG\ ER_{annual} = \left(41 \frac{metric\ tons\ CO2e}{year}\right) - \left(11 \frac{metric\ tons\ CO2e}{year}\right)$$

$$= 30 \frac{metric\ tons\ CO2e}{year}$$

Step 5: Determine the annual criteria pollutant emission reductions that are associated with the proposed project. The baseline diesel-fueled forklift is using a 110 hp diesel engine that is certified to the Tier 4 Final emissions standard, therefore, using emission values from Table IV-7 and fuel consumption rate factors from Table IV-19, the result of Step 1 above to populate Formula 13. The forklift will be used 100% of the time in California. There are no criteria pollutant emissions associated with the use of the battery-electric forklift in a tank-to-wheel analysis.

For a Tier 4 Final off-road engine at 110 hp, Table IV-7 gives criteria pollutant emissions per bhp-hr and Table IV-5 gives the load factor. Therefore:

NOx = 0.26 $\frac{g\ NOx}{bhp-hr}$; ROG = 0.06 $\frac{g\ ROG}{bhp-hr}$; PM10 = 0.008 $\frac{g\ PM10}{bhp-hr}$

Load Factor$_{\text{industrial forklift}}$ = 0.20

Formula 12:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * Horsepower * Load Factor * Activity (hrs/yr) * Percent Operation in California * ton/907,200g*

$$Annual\ ER_{NOx} = \left(0.26 \frac{g\ NOx}{bhp-hr}\right) * (110\ hp) * (0.20) * \left(1{,}500 \frac{hours}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.009 \frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.06 \frac{g\ NOx}{bhp-hr}\right) * (110\ hp) * (0.20) * \left(1{,}500 \frac{hours}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.002 \frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(0.008 \frac{g\ PM10}{bhp-hr}\right) * (110\ hp) * (0.20) * \left(1{,}500 \frac{hours}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.0003 \frac{tons\ PM10}{year}$$

Step 6: Determine the weighted annual surplus emission reductions that are associated with the proposed project. Use the results from Step 5 above along with the realization that the proposed battery-electric forklift will not produce any criteria pollutant emissions in a tank-to-wheel scenario to populate Formula 11.

Formula 11:

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

$$WER = \left(0.009\ \frac{tons\ NOx}{year}\right) + \left(0.002\frac{tons\ ROG}{year}\right) + \left(20 * 0.0003\frac{tons\ PM}{year}\right)$$

$$= 0.017\ \frac{tons}{year}$$

Step 7: Determine the incremental cost of the proposed technology using Formula 10 and the equipment costs for the baseline diesel-fueled forklift and the battery-electric heavy lift forklift given at the start of this example. Cost-effectiveness is to be calculated for two scenarios; for two years during the demonstration and for 10 years, two years after the completion of the demonstration project.

Baseline Equipment:
- Forklift cost at Demonstration: $40,000
- Forklift cost two years after demonstration: $40,000

Advanced Technology:
- Forklift cost at demonstration: $75,000
- Forklift cost two years after demonstration: $65,000

Formula 10:

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

Incremental Cost$_{2\ years}$ = $75,000 – $40,000 = $35,000

Incremental Cost$_{10\ years}$ = $65,000 – $40,000 = $25,000

Step 8: Determine the GHG emission reduction cost-effectiveness for the proposed project using Formula 5 and the results from Step 4 and Step 7.

Formula 5:

$$GHG\ Cost\ Effectiveness\ \left(\frac{\$}{metric\ ton\ CO2e}\right) = \frac{CRF * incremental\ cost}{Project\ GHG\ ER_{annual}}$$

Where, for the purposes of this Solicitation:
- **CRF** is the Capital Recovery Factor;

- **CRF_2 = 0.515**, per Moyer Table G-3a (2-year life);
- **CRF_{10} = 0.111**, per Moyer Table G-3a (10-year life); and
- **Incremental cost** is the difference between the cost of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

$$GHG\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$35{,}000)}{\left(30\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$601\ per\ metric\ ton\ CO2e\ reduced$$

$$GHG\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$25{,}000)}{\left(30\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$93\ per\ metric\ ton\ CO2e\ reduced$$

Step 9: Determine the criteria pollutant cost-effectiveness for the proposed technology. Use the results from Step 6 and Step 7 to populate Formula 8.

Formula 8:

$$\textit{Cost-Effectiveness (\$/ton)} = \frac{\textit{Annualized Cost (\$/year)}}{\textit{Annual Weighted Surplus Emission Reductions (tons/year)}}$$

$$WER\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$35{,}000)}{\left(0.017\ \frac{tons\ WER}{year}\right)}$$

$$= \$1{,}060{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

$$WER\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$25{,}000)}{\left(0.017\ \frac{tons\ WER}{year}\right)}$$

$$= \$163{,}200\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

Example B: Fuel Cell Top Handler

Potential GHG emission reductions are determined on a well-to-wheel basis, while criteria pollutant emission reductions are determined using a tank-to-wheel analysis. This example assumes that a fuel cell top handler will have the same energy requirements as a diesel counterpart and will be used the same number of hours. It is assumed that this project will use hydrogen that is SB 1505 compliant and therefore, has 1/3 renewable component.

Baseline Diesel Top Handler:

- Off-road diesel engine: Tier 4 final certification, 300 hp
- Diesel usage: 7.5 gallons per hour
- Operation: 2,500 hours per year, 18,750 gallons of diesel consumed per year
- Top handler cost at demonstration: $550,000
- Top handler cost two years after demonstration: $550,000

Advanced Technology:

- Hydrogen fuel cell top handler
- Top Handler cost at demonstration: $1,000,000
- Top Handler cost two years after demonstration: $750,000

Variables Used in Calculation:

Carbon Intensity

From Table II-2: Fuel Carbon Intensity Values

CI = Carbon Intensity

$CI_{diesel} = \frac{102.01\ g\ CO2e}{MJ}$ Table Pathway Identifier ULSD001

$CI_{hydrogen} = \frac{88.33\ g\ CO2e}{MJ}$ Table Pathway Identifier HYGN005

Energy Density

From Table II-1: Fuel Energy Density

ED = Energy Density

$ED_{diesel} = \frac{134.47\ MJ}{gal\ diesel}$ $ED_{hydrogen} = \frac{120.00\ MJ}{kg}$

Energy Efficiency Ratio

From Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications

EER = Energy Efficiency Ratio (unit less)

$EER_{\text{fuel cell vehicle}}$ = 1.9

Step 1: Convert the diesel used per year to the amount of hydrogen needed to do the same work using Formula 3 and the variables identified above.

Formula 3:

$$Replacement\ Fuel\ Usage\left(\frac{unit}{year}\right) = fuel\ usage * ED_{diesel} * \left(\frac{1}{ED_{replacement\ fuel}}\right) * \left(\frac{1}{EER}\right)$$

Where:

- **ED** is the fuel energy density (see Table II-1: Fuel Energy Density);
- **EER** is the Energy Economy Ratio value for fuels relative to diesel (see Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications);
- **Unit** is the units associated with the replacement fuel. Electricity is in terms of kWh, hydrogen is in kg, and CNG is in scf.

$$Replacement\ Fuel\ Usage\left(\frac{unit}{year}\right) = \left(\frac{18{,}750\ gal\ diesel}{year}\right) * \left(\frac{134.47\ MJ}{1\ gal\ diesel}\right) * \left(\frac{1\ kg}{120.00\ MJ}\right) * \left(\frac{1}{1.9}\right)$$

$$= 11{,}058\ \frac{kg\ hydrogen}{year}$$

Step 2: Determine the GHG emissions that are attributed to the baseline diesel-fueled top handler. Using Formula 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right)$$

$$* \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{base} = \left(\frac{102.01\ g\ CO2e}{MJ}\right) * \left(\frac{134.47\ MJ}{gal\ diesel}\right) * \left(\frac{18{,}750\ gal\ diesel}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 257 \frac{metric\ tons\ CO2e}{year}$$

Step 3: Determine the GHG emissions that are attributed to the advanced technology top handler. Using Formula 1, the result from Step 1 and the variables identified above.

Formula 1:

$$GHG\ EF \left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{ATV} = \left(\frac{88.33\ gram\ CO2e}{MJ}\right) * \left(\frac{120.00\ MJ}{kg}\right) * \left(\frac{11{,}058\ kg}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 117 \frac{metric\ tons\ CO2e}{year}$$

Step 4: Determine the GHG emission reductions that are associated with the proposed project. Using Formula 4, populated by results from Step 2 and Step 3 above to give the GHG emission benefit from the proposed project.

Formula 4:

$$Project\ GHG\ ER_{annual} \left(\frac{metric\ tons\ CO2e}{year}\right) = GHG\ EF_{base} - GHG\ EF_{ATV}$$

Where:

- **GHG ER_{annual}** is the annual GHG emission reductions that are associated with the proposed project;
- **GHG EF_{base}** is the GHG emission factor associated with the base case vehicle or equipment that the advanced technology vehicle or equipment is compared against; and
- **GHG ER_{ATV}** is the GHG emission factor that is associated with the proposed advanced technology vehicle.

$$Project\ GHG\ ER_{annual} = \left(257 \frac{metric\ tons\ CO2e}{year}\right) - \left(117 \frac{metric\ tons\ CO2e}{year}\right)$$

$$= 140 \frac{metric\ tons\ CO2e}{year}$$

Step 5: Determine the annual criteria pollutant emission reductions that are associated with the proposed project. The baseline diesel-fueled top handler is using a 300 hp diesel engine that is certified to the Tier 4 Final emissions standard, therefore, using emission values from Table IV-7 and off-road load factors from Table IV-5, the result of Step 1 above to populate Formula 12. The top handler will be used 100% of the time in California. There are no criteria pollutant emissions associated with the use of the hydrogen fuel cell top handler in a tank-to-wheel analysis.

For a Tier 4 Final off-road engine at 300 hp, Table IV-7 gives criteria pollutant emissions per bhp-hr and Table IV-5 gives the load factor. Therefore:

NOx = 0.26 $\frac{g\ NOx}{bhp-hr}$; ROG = 0.06 $\frac{g\ ROG}{bhp-hr}$; PM10 = 0.008 $\frac{g\ PM10}{bhp-hr}$

Load Factor$_{\text{container handling equipment}}$ = 0.59

Formula 12:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * Horsepower * Load Factor * Activity (hrs/yr) * Percent Operation in California * ton/907,200g*

$$Annual\ ER_{NOx} = \left(0.26 \frac{g\ NOx}{bhp-hr}\right) * (300\ hp) * (0.59) * \left(2{,}500 \frac{hours}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.127 \frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.06 \frac{g\ NOx}{bhp-hr}\right) * (300\ hp) * (0.59) * \left(2{,}500 \frac{hours}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.029 \frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(\frac{0.008\ g\ PM10}{bhp-hr}\right) * (300\ hp) * (0.59) * \left(2{,}500 \frac{hours}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.004 \frac{tons\ PM10}{year}$$

Step 6: Determine the weighted annual surplus emission reductions that are associated with the proposed project. Using the results from Step 5 above along with the realization that the proposed battery-electric forklift will not produce any criteria pollutant emissions in a tank-to-wheel scenario, populate Formula 11.

Formula 11:

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

$$WER = \left(0.127\ \frac{tons\ NOx}{year}\right) + \left(0.029\frac{tons\ ROG}{year}\right) + \left(20 * 0.004\frac{tons\ PM}{year}\right)$$

$$= 0.236\ \frac{tons}{year}$$

Step 7: Determine the incremental cost of the proposed technology using Formula 10 and the equipment costs for the baseline diesel-fueled top handler and the fuel cell top handler given at the start of this example. Cost-effectiveness is to be calculated for two scenarios; for two years during the demonstration and for 10 years, two years after the completion of the demonstration project.

Baseline Equipment:
- Top handler cost at Demonstration: $550,000
- Top handler cost two years after demonstration: $550,000

Advanced Technology:
- Top handler cost at demonstration: $1,000,000
- Top handler cost two years after demonstration: $750,000

Formula 10:

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

Incremental $\text{Cost}_{\text{2 years}}$ = $1,000,000 – $550,000 = $450,000

Incremental $\text{Cost}_{\text{10 years}}$ = $750,000 – $550,000 = $200,000

Step 8: Determine the GHG emission reduction cost-effectiveness for the proposed project using Formula 5 and the results from Step 4 and Step 7.

Formula 5:

$$Cost\ Effectiveness\ \left(\frac{\$}{metric\ ton\ CO2e}\right) = \frac{CRF * incremental\ cost}{Project\ GHG\ ER_{annual}}$$

Where, for the purposes of this Solicitation:

- **CRF** is the Capital Recovery Factor;
- **CRF_2 = 0.515**, per Moyer Table G-3a (2-year life);
- **CRF_{10} = 0.111**, per Moyer Table G-3a (10-year life); and
- **Incremental cost** is the difference between the cost of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

$$GHG\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$450{,}000)}{\left(140\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$1{,}655\ per\ metric\ ton\ CO2e\ reduced$$

$$GHG\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$200{,}000)}{\left(140\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$159\ per\ metric\ ton\ CO2e\ reduced$$

Step 9: Determine the criteria pollutant cost-effectiveness for the proposed technology. Use the results from Step 6 and Step 7 to populate Formula 8.

Formula 8:

$$\text{Cost-Effectiveness (\$/ton)} = \frac{\text{Annualized Cost (\$/year)}}{\text{Annual Weighted Surplus Emission Reductions (tons/year)}}$$

$$WER\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$450{,}000)}{\left(0.236\ \frac{tons\ WER}{year}\right)}$$

$$= \$982{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

$$WER\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$200{,}000)}{\left(0.236\ \frac{tons\ WER}{year}\right)}$$

$$= \$94{,}100\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

Example C: Battery-Electric Switch Locomotive with Fuel Cell Range Extender

Potential GHG emission reductions are determined on a well-to-wheel basis, while criteria pollutant emission reductions are determined using a tank-to-wheel analysis. This example assumes that a fuel cell locomotive with battery storage will have the same energy requirements as a diesel-electric counterpart and will be used the same number of hours. Further, it is assumed that in this project, continuous power is provided by the fuel cell and peak power requirements are provided by the on-board traction battery. It is assumed that half of the advanced technology vehicle's energy needs will come from the on-board battery pack and that half of the vehicle's energy needs will come from the on-board range extending engine. It is assumed that this project will use hydrogen that is SB 1505 compliant and therefore, has 1/3 renewable component.

Baseline Locomotive:

- Off-road diesel engine with electric drivetrain: Tier 4 certification, 1,500 hp
- Diesel usage: 23 gallons per hour
- Operation: 6,000 hours per year, 138,000 gallons per year
- Locomotive cost at demonstration: $1,500,000
- Locomotive cost two years after demonstration: $1,500,000

Advanced Technology:

- Battery-electric locomotive with fuel cell range extender
- Energy requirements during operation: 50% on electricity, 50% on hydrogen
- Locomotive cost at demonstration: $3,500,000
- Locomotive cost two years after demonstration: $2,500,000

Variables Used in Calculation:

Carbon Intensity

From Table II-2: Fuel Carbon Intensity Values

CI = Carbon Intensity

$CI_{diesel} = \frac{102.01\ g\ CO2e}{MJ}$ Table Pathway Identifier ULSD001

$CI_{electricity} = \frac{105.16\ g\ CO2e}{MJ}$ Table Pathway Identifier ELC001

$CI_{hydrogen} = \frac{88.33\ g\ CO2e}{MJ}$ Table Pathway Identifier HYGN005

Energy Density

From Table II-1: Fuel Energy Density

ED = Energy Density

$ED_{diesel} = \frac{134.47\ MJ}{gal\ diesel}$ $ED_{hydrogen} = \frac{120.00\ MJ}{kg}$

$ED_{electricity} = \frac{3.60\ MJ}{kWh}$

Energy Efficiency Ratio

From Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications

EER = Energy Efficiency Ratio (unit less)

$EER_{electric\ heavy\ rail} = 4.6$ $EER_{fuel\ cell\ vehicle} = 1.9$

Step 1: Convert the diesel used per year to the amount of electricity and hydrogen needed to do the same work using Formula 3 and the variables identified above.

Formula 3:

$$Replacement\ Fuel\ Usage\left(\frac{unit}{year}\right) = fuel\ usage * ED_{diesel} * \left(\frac{1}{ED_{replacement\ fuel}}\right) * \left(\frac{1}{EER}\right)$$

Where:

- **ED** is the fuel energy density (see Table II-1: Fuel Energy Density);
- **EER** is the Energy Economy Ratio value for fuels relative to diesel (see Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications);
- **Unit** is the units associated with the replacement fuel. Electricity is in terms of kWh, hydrogen is in kg, and CNG is in scf.

$$Replacement\ Fuel\ Usage_{electricity} = \left(\frac{69{,}000\ gal\ diesel}{year}\right) * \left(\frac{134.47\ MJ}{1\ gal\ diesel}\right) * \left(\frac{1\ kWh}{3.60\ MJ}\right) * \left(\frac{1}{4.6}\right)$$
$$= 560{,}000\ \frac{kWh}{year}$$

$$Replacement\ Fuel\ Usage_{hydrogen} = \left(\frac{69{,}000\ gal\ diesel}{year}\right) * \left(\frac{134.47\ MJ}{1\ gal\ diesel}\right) * \left(\frac{1\ kg}{120.00\ MJ}\right) * \left(\frac{1}{1.9}\right)$$
$$= 40{,}700\ \frac{kg\ hydrogen}{year}$$

Step 2: Determine the GHG emissions that are attributed to the baseline diesel-fueled locomotive using Formula 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{base} = \left(\frac{102.01\ g\ CO2e}{MJ}\right) * \left(\frac{134.47\ MJ}{gal\ diesel}\right) * \left(\frac{138{,}000\ gal\ diesel}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 1{,}893\ \frac{metric\ tons\ CO2e}{year}$$

Step 3: Determine the GHG emissions that are attributed to the advanced technology locomotive. Use Formula 1, the result from Step 1, and the variables identified above to calculate the GHG emissions for electricity and hydrogen separately, then add together.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{electricity} = \left(\frac{105.16\ g\ CO2e}{MJ}\right) * \left(\frac{3.60\ MJ}{kWh}\right) * \left(\frac{560{,}000\ kWh}{year}\right) * \left(\frac{metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 212\frac{metric\ tons\ CO2e}{year}$$

$$GHG\ EF_{hydrogen} = \left(\frac{88.33\ g\ CO2e}{MJ}\right) * \left(\frac{120.00\ MJ}{kg}\right) * \left(\frac{40{,}700\ kg}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 431\frac{metric\ tons\ CO2e}{year}$$

$$GHG\ EF_{ATV} = \left(212\frac{metric\ tons\ CO2e}{year}\right) + \left(431\frac{metric\ tons\ CO2e}{year}\right)$$

$$= 643\frac{metric\ tons\ CO2e}{year}$$

Step 4: Determine the GHG emission reductions that are associated with the proposed project. Use Formula 4, populated by results from Step 2 and Step 3 above, to give the GHG emission benefit from the proposed project.

Formula 4:

$$Project\ GHG\ ER_{annual}\left(\frac{metric\ tons\ CO2e}{year}\right) = GHG\ EF_{base} - GHG\ EF_{ATV}$$

Where:

- **GHG ER_{annual}** is the annual GHG emission reductions that are associated with the proposed project;
- **GHG EF_{base}** is the GHG emission factor associated with the base case vehicle or equipment that the advanced technology vehicle or equipment is compared against; and
- **GHG ER_{ATV}** is the GHG emission factor that is associated with the proposed advanced technology vehicle.

$$Project\ GHG\ ER_{annual} = \left(1{,}893\frac{metric\ tons\ CO2e}{year}\right) - \left(643\frac{metric\ tons\ CO2e}{year}\right)$$

$$= 1{,}250\frac{metric\ tons\ CO2e}{year}$$

Step 5: Determine the annual criteria pollutant emission reductions that are associated with the proposed project. The baseline locomotive is using a 1,500 hp diesel engine that is certified to the Tier 4 emissions standard, therefore, using emission values from Table IV-12b and fuel consumption rate factors from Table IV-19, the result of Step 1 above to populate Formula 13. The locomotive will be used 100% of the time in California. There are no criteria pollutant emissions associated with the use of the battery-electric locomotive with the fuel cell range extender in a tank-to-wheel analysis.

For a Tier 4 locomotive engine at 1,500 hp, Table IV-12b gives criteria pollutant emissions per bhp-hr and Table IV-19 gives the fuel consumption rate factor. Therefore:

NOx = 1.22 $\frac{g\ NOx}{bhp-hr}$; ROG = 0.15 $\frac{g\ ROG}{bhp-hr}$; PM10 = 0.026 $\frac{g\ PM10}{bhp-hr}$

Formula 13:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

$$Annual\ ER_{NOx} = \left(1.22 \frac{g\ NOx}{bhp-hr}\right) * \left(15.2 \frac{bhp-hr}{gal\ diesel}\right) * \left(138{,}000 \frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 2.821 \frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.15 \frac{g\ ROG}{bhp-hr}\right) * \left(15.2 \frac{bhp-hr}{gal\ diesel}\right) * \left(138{,}000 \frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.347 \frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(0.026 \frac{g\ PM10}{bhp-hr}\right) * \left(15.2 \frac{bhp-hr}{gal\ diesel}\right) * \left(138{,}000 \frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.060 \frac{tons\ PM10}{year}$$

Step 6: Determine the weighted annual surplus emission reductions that are associated with the proposed project. Use the results from Step 5 above, along with the realization that the proposed battery-electric locomotive with a fuel cell range extender will not produce any criteria pollutant emissions in a tank-to-wheel scenario, to populate Formula 11.

Formula 11:

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

$$WER = \left(2.821\ \frac{tons\ NOx}{year}\right) + \left(0.347 \frac{tons\ ROG}{year}\right) + \left(20 * 0.060 \frac{tons\ PM}{year}\right)$$

$$= 4.368 \frac{tons}{year}$$

Step 7: Determine the incremental cost of the proposed technology using Formula 10 and the equipment costs for the baseline locomotive and the battery-electric locomotive with a fuel cell range extender given at the start of this example. Cost-effectiveness is to be calculated for two scenarios; for two years during the demonstration and for 10 years, two years after the completion of the demonstration project.

Baseline Equipment:

- Locomotive cost at Demonstration: $1,500,000
- Locomotive cost two years after demonstration: $1,500,000

Advanced Technology:

- Locomotive cost at demonstration: $3,500,000
- Locomotive cost two years after demonstration: $2,500,000

Formula 10:

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

Incremental Cost$_{2\ years}$ = $3,500,000 – $1,500,000 = $2,000,000

Incremental Cost$_{10\ years}$ = $2,500,000 – $1,500,000 = $1,000,000

Step 8: Determine the GHG emission reduction cost-effectiveness for the proposed project using Formula 5 and the results from Step 4 and Step 7.

Formula 5:

$$Cost\ Effectiveness\ \left(\frac{\$}{metric\ ton\ CO2e}\right) = \frac{CRF * incremental\ cost}{Project\ GHG\ ER_{annual}}$$

Where, for the purposes of this Solicitation:

- **CRF** is the Capital Recovery Factor;
- **CRF_2 = 0.515**, per Moyer Table G-3a (2-year life);
- **CRF_{10} = 0.111**, per Moyer Table G-3a (10-year life); and
- **Incremental cost** is the difference between the cost of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

$$GHG\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$2{,}000{,}000)}{\left(1{,}250\,\frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$824\ per\ metric\ ton\ CO2e\ reduced$$

$$GHG\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$1{,}000{,}000)}{\left(1{,}250\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$89\ per\ metric\ ton\ CO2e\ reduced$$

Step 9: Determine the criteria pollutant cost-effectiveness for the proposed technology. Use the results from Step 6 and Step 7 to populate Formula 8.

Formula 8:

$$\textit{Cost-Effectiveness (\$/ton)} = \frac{\textit{Annualized Cost (\$/year)}}{\textit{Annual Weighted Surplus Emission Reductions (tons/year)}}$$

$$WER\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$2{,}000{,}000)}{\left(4.368\ \frac{tons\ WER}{year}\right)}$$

$$= \$236{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

$$WER\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$1{,}000{,}000)}{\left(4.368\ \frac{tons\ WER}{year}\right)}$$

$$= \$25{,}400\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

Example D: Hybrid Wheel Loader with Renewable Diesel

Potential GHG emission reductions are determined on a well-to-wheel basis, while criteria pollutant emission reductions are determined using a tank-to-wheel analysis. This example assumes that a hybrid wheel loader will have the same energy requirements as a diesel counterpart and will be used the same number of hours. It is assumed that the hybrid system reduces the equipment's fuel consumption by 15% and renewable diesel is used instead of traditional diesel.

Baseline Diesel Wheel Loader:

- Off-road diesel engine: Tier 4 final certification, 500 hp
- Diesel usage: 8 gallons per hour
- Operation: 1,500 hours per year, 12,000 gallons of diesel consumed per year
- Wheel Loader cost at demonstration: $800,000
- Wheel Loader cost two years after demonstration: $800,000

Advanced Technology:

- Hybrid wheel loader (Tier 4 final engine) with renewable diesel
- Renewable diesel usage: 6.8 gallons per hour
- Wheel Loader cost at demonstration: $1,400,000
- Wheel Loader cost two years after demonstration: $1,000,000

Variables Used in Calculation:

Carbon Intensity

From Table II-2: Fuel Carbon Intensity Values

CI = Carbon Intensity

$CI_{diesel} = \frac{102.01\ g\ CO2e}{MJ}$ Table Pathway Identifier ULSD001

$CI_{renewable\ diesel} = \frac{102.01\ g\ CO2e}{MJ}$ Table Pathway Identifier RNWD302T

Energy Density

From Table II-1: Fuel Energy Density

ED = Energy Density

$ED_{diesel} = \frac{134.47\ MJ}{gal\ diesel}$ $ED_{renewable\ diesel} = \frac{129.65\ MJ}{gal\ RD}$

Energy Efficiency Ratio

From Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications

EER = Energy Efficiency Ratio (unit less)

EER_{diesel} = 1.0

Step 1: Calculate the amount of conventional diesel needed to operate the advanced technology vehicle. Use Formula 7 and the baseline information above.

Formula 7:

$$Fuel\ Usage_{ATV}\left(\frac{gal}{year}\right) = \ fuel\ usage * \left(1 - \frac{(X * Y\%\ improvement)}{100\%}\right)$$

Where:

- **X** is the fraction of the time the advanced operational efficiency technology or logistic strategy is enabled and providing emission reductions. If the advanced operational efficiency technology or logistic strategy is always engaged and providing emission reductions assume that X is equal to 1; and
- **Y** is the percentage fuel economy improvement that is gained by having the advanced operational efficiency technology or logistic strategy efficiency improvement over the baseline engine.

$$Fuel\ Usage_{ATV}\left(\frac{gal}{year}\right) = \ \left(\frac{12{,}000\ gal\ diesel}{year}\right) * \left(1 - \frac{(1 * 15\%\ improvement)}{100\%}\right)$$

$$= 10{,}200\,\frac{gal\ diesel}{year}$$

Step 2: Convert the diesel used per year to the amount of renewable diesel needed to do the same work. Use Formula 3 and the variables identified above.

Formula 3:

$$Replacement\ Fuel\ Usage\left(\frac{unit}{year}\right) = fuel\ usage * ED_{diesel} * \left(\frac{1}{ED_{replacement\ fuel}}\right) * \left(\frac{1}{EER}\right)$$

Where:

- **ED** is the fuel energy density (see Table II-1: Fuel Energy Density);
- **EER** is the Energy Economy Ratio value for fuels relative to diesel (see Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications);

- **Unit** is the units associated with the replacement fuel. Electricity is in terms of kWh, hydrogen is in kg, and CNG is in scf.

$$Replacement\ Fuel\ Usage = \left(\frac{10{,}200\ gal\ diesel}{year}\right) * \left(\frac{134.47\ MJ}{1\ gal\ diesel}\right) * \left(\frac{1\ gal\ RD}{129.65\ MJ}\right) * \left(\frac{1}{1.0}\right)$$

$$= 10{,}580\ \frac{gal\ renewable\ diesel}{year}$$

Step 3: Determine the GHG emissions that are attributed to the baseline diesel-fueled wheel loader using Formula 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right)$$

$$* \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{base} = \left(\frac{102.01\ g\ CO2e}{MJ}\right) * \left(\frac{134.47\ MJ}{gal\ diesel}\right) * \left(\frac{12{,}000\ gal\ diesel}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 165\,\frac{metric\ tons\ CO2e}{year}$$

Step 4: Determine the GHG emissions that are attributed to the advanced technology wheel loader using Formula 1, the result from Step 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right)$$

$$* \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{ATV} = \left(\frac{102.01\ g\ CO2e}{MJ}\right) * \left(\frac{129.65\ MJ}{gal\ RD}\right) * \left(\frac{10{,}580\ gal\ RD}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 140\frac{metric\ tons\ CO2e}{year}$$

Step 5: Determine the GHG emission reductions that are associated with the proposed project. Using Formula 4, populated by results from Step 3 and Step 4 above to give the GHG emission benefit from the proposed project.

Formula 4:

$$Project\ GHG\ ER_{annual}\left(\frac{metric\ tons\ CO2e}{year}\right) = GHG\ EF_{base} - GHG\ EF_{ATV}$$

Where:

- **GHG ER$_{annual}$** is the annual GHG emission reductions that are associated with the proposed project;
- **GHG EF$_{base}$** is the GHG emission factor associated with the base case vehicle or equipment that the advanced technology vehicle or equipment is compared against; and
- **GHG ER$_{ATV}$** is the GHG emission factor that is associated with the proposed advanced technology vehicle.

$$Project\ GHG\ ER_{annual} = \left(165\frac{metric\ tons\ CO2e}{year}\right) - \left(140\frac{metric\ tons\ CO2e}{year}\right)$$

$$= 25\frac{metric\ tons\ CO2e}{year}$$

Step 6: Determine the annual criteria pollutant emissions that are associated with the baseline wheel loader. The baseline wheel loader is using a 500 hp diesel engine that is certified to the Tier 4 Final emissions standard, therefore, using emission values from Table IV-7 and fuel consumption rate factors from Table IV-19, the result of Step 1 above to populate Formula 12. The wheel loader will be used 100% of the time in California.

For a Tier 4 Final off-road engine at 500 hp, Table IV-7 gives criteria pollutant emissions per bhp-hr and Table-24 gives the fuel consumption rate factors. Therefore:

NOx = 0.26 $\frac{g\ NOx}{bhp-hr}$; ROG = 0.06 $\frac{g\ ROG}{bhp-hr}$; PM10 = 0.008 $\frac{g\ PM10}{bhp-hr}$

Formula 13:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

$$Annual\ ER_{NOx} = \left(0.26\,\frac{g\ NOx}{bhp\text{-}hr}\right) * \left(18.5\,\frac{bhp\text{-}hr}{gal\ diesel}\right) * \left(12{,}000\,\frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.064\,\frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.06\,\frac{g\ ROG}{bhp\text{-}hr}\right) * \left(18.5\,\frac{bhp\text{-}hr}{gal\ diesel}\right) * \left(12{,}000\,\frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.015\,\frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(0.008\,\frac{g\ PM10}{bhp\text{-}hr}\right) * \left(18.5\,\frac{bhp\text{-}hr}{gal\ diesel}\right) * \left(12{,}000\,\frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.002\,\frac{tons\ PM10}{year}$$

Step 7: Determine the annual criteria pollutant emissions that are associated with the hybrid wheel loader. The hybrid wheel loader is using a 500 hp diesel engine that is certified to the Tier 4 Final emissions standard, therefore, using emission values from Table IV-7 and fuel consumption rate factors from Table IV-19, the result of Step 2 above to populate Formula 12. The wheel loader will be used 100% of the time in California.

Formula 13:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

$$Annual\ ER_{NOx} = \left(0.26\,\frac{g\ NOx}{bhp\text{-}hr}\right) * \left(18.5\,\frac{bhp\text{-}hr}{gal}\right) * \left(10{,}580\,\frac{gal\ RD}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.056\,\frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.06 \frac{g\ ROG}{bhp-hr}\right) * \left(18.5 \frac{bhp-hr}{gal}\right) * \left(10{,}580 \frac{gal\ RD}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.013 \frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(0.008 \frac{g\ PM10}{bhp-hr}\right) * \left(18.5 \frac{bhp-hr}{gal}\right) * \left(10{,}580 \frac{gal\ RD}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.002 \frac{tons\ PM10}{year}$$

Step 8: Determine the weighted annual emissions reductions that are associated with the proposed project. Using the results from Step 6 and Step 7 above, populate Formula 11.

Formula 11:

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

$$WER = \left(0.064 - 0.056 \frac{tons\ NOx}{year}\right) + \left(0.015 - 0.013 \frac{tons\ ROG}{year}\right) + \left(20 * (0.002 - 0.002) \frac{tons\ PM}{year}\right)$$

$$= 0.010\ \frac{tons}{year}$$

Step 9: Determine the incremental cost of the proposed technology using Formula 10 and the equipment costs for the baseline wheel loader and the hybrid wheel loader given at the start of this example. Cost-effectiveness is to be calculated for two scenarios; for two years during the demonstration and for 10 years, two years after the completion of the demonstration project.

Baseline Equipment:

- Wheel loader cost at Demonstration: $800,000
- Wheel loader cost two years after demonstration: $800,000

Advanced Technology:

- Wheel loader cost at demonstration: $1,400,000
- Wheel loader cost two years after demonstration: $1,000,000

Formula 10:

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

Incremental Cost$_{2\ years}$ = $1,400,000 – $800,000 = $600,000

Incremental $\text{Cost}_{10\ years}$ = \$1,000,000 – \$800,000 = \$200,000

Step 10: Determine the GHG emission reduction cost-effectiveness for the proposed project using Formula 5 and the results from Step 5 and Step 9.

Formula 5:

$$Cost\ Effectiveness\ \left(\frac{\$}{metric\ ton\ CO2e}\right) = \frac{CRF * incremental\ cost}{Project\ GHG\ ER_{annual}}$$

Where, for the purposes of this Solicitation:

- **CRF** is the Capital Recovery Factor;
- **CRF_2 = 0.515**, per Moyer Table G-3a (2-year life);
- **CRF_{10} = 0.111**, per Moyer Table G-3a (10-year life); and
  Incremental cost is the difference between the cost of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

$$GHG\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$600{,}000)}{\left(25\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$12{,}360\ per\ metric\ ton\ CO2e\ reduced$$

$$GHG\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$200{,}000)}{\left(25\ \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$888\ per\ metric\ ton\ CO2e\ reduced$$

Step 11: Determine the criteria pollutant cost-effectiveness for the proposed technology. Use the results from Step 8 and Step 9 to populate Formula 8.

Formula 8:

$$\textit{Cost-Effectiveness (\$/ton)} = \frac{\textit{Annualized Cost (\$/year)}}{\textit{Annual Weighted Surplus Emission Reductions (tons/year)}}$$

$$WER\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$600{,}000)}{\left(0.010\ \frac{tons\ WER}{year}\right)}$$

$$= \$30{,}900{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

$$WER\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$200{,}000)}{\left(0.010\ \frac{tons\ WER}{year}\right)}$$

$$= \$2{,}220{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

Example E: Logistic Strategy for Container Movement Technology

Potential GHG emission reductions are determined on a well-to-wheel basis, while criteria pollutant emission reductions are determined using a tank-to-wheel analysis. This example assumes that a piece of cargo handling equipment utilizing advanced logistic technology will have the same energy requirements as a diesel counterpart without the logistic technology and will be used the same number of hours. The logistic strategy is only functional while loading and unloading ocean going vessels and, therefore, will only be engaged half of the time during the cargo handling equipment's operation.

Baseline Vehicle:

- Top handler with off-road diesel engine: Tier 4 final certification, 300 hp
- Diesel usage: 7.5 gallons per hour
- Operation: 2,500 hours per year, 18,750 gallons of diesel consumed per year
- Top handler cost at demonstration: $550,000
- Top handler cost two years after demonstration: $550,000

Advanced Technology:

- Top handler with off-road diesel engine: Tier 4 final certification, 300 hp
- Operation: 2,500 hours per year
    - 50% of operation is loading and unloading ocean going vessels
- Logistic system provides a 5% increase in fuel economy while loading and unloading ocean going vessels
- Top handler with logistic technology cost at demonstration: $590,000
- Top handler with logistic technology two years after demonstration: $575,000

Variables Used in Calculation:

Carbon Intensity

From Table II-2: Fuel Carbon Intensity Values

CI = Carbon Intensity

$CI_{diesel} = \frac{102.01\ g\ CO2e}{MJ}$ Table Pathway Identifier ULSD001

Energy Density

From Table II-1: Fuel Energy Density

ED = Energy Density

$ED_{diesel} = \frac{134.47\ MJ}{gal\ diesel}$

Energy Efficiency Ratio

From Table II-3: EER Values for Fuels Used in Light- Medium- and Heavy-Duty Applications

EER = Energy Efficiency Ratio (unit less)

$EER_{diesel} = 1.0$

Step 1: Calculate the amount of diesel needed to operate the advanced technology vehicle. Use Formula 7 and the baseline information above.

Formula 7:

$$Fuel\ Usage_{ATV}\left(\frac{gal}{year}\right) = fuel\ usage * \left(1 - \frac{(X * Y\%\ improvement)}{100\%}\right)$$

Where:
- **X** is the fraction of the time the advanced operational efficiency technology or logistic strategy is enabled and providing emission reductions. If the advanced operational efficiency technology or logistic strategy is always engaged and providing emission reductions assume that X is equal to 1; and
- **Y** is the percentage fuel economy improvement that is gained by having the advanced operational efficiency technology or logistic strategy efficiency improvement over the baseline engine.

$$Fuel\ Usage_{ATV}\left(\frac{gal}{year}\right) = \left(\frac{18{,}750\ gal\ diesel}{year}\right) * \left(1 - \frac{(0.5 * 5\%\ improvement)}{100\%}\right)$$

$$= 18{,}280\,\frac{gal\ diesel}{year}$$

Step 2: Determine the GHG emissions that are attributed to the baseline vehicle using Formula 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{base} = \left(\frac{102.01\ g\ CO2e}{MJ}\right) * \left(\frac{134.47\ MJ}{gal\ diesel}\right) * \left(\frac{18{,}750\ gal\ diesel}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 257 \frac{metric\ tons\ CO2e}{year}$$

Step 3: Determine the GHG emissions that are attributed to the advanced technology vehicle using Formula 1, the result from Step 1 and the variables identified above.

Formula 1:

$$GHG\ EF\left(\frac{metric\ tons\ CO2e}{year}\right) = CI * fuel\ energy\ density * fuel\ usage * \frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}$$

$$= \left(\frac{gram\ CO2e}{MJ}\right) * \left(\frac{MJ}{gal}\ or\ \frac{MJ}{kg}\ or\ \frac{MJ}{scf}\ or\ \frac{MJ}{kWh}\right) * \left(\frac{gal}{year}\ or\ \frac{kg}{year}\ or\ \frac{scf}{year}\ or\ \frac{kWh}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$GHG\ EF_{ATV} = \left(\frac{102.01\ g\ CO2e}{MJ}\right) * \left(\frac{134.47\ MJ}{gal\ diesel}\right) * \left(\frac{18{,}280\ gal\ diesel}{year}\right) * \left(\frac{1\ metric\ ton\ CO2e}{1{,}000{,}000\ grams}\right)$$

$$= 251 \frac{metric\ tons\ CO2e}{year}$$

Step 4: Determine the GHG emission reductions that are associated with the proposed project. Use Formula 4, populated by results from Step 3 and Step 4 above, to give the GHG emission benefit from the proposed project.

Formula 4:

$$Project\ GHG\ ER_{annual}\left(\frac{metric\ tons\ CO2e}{year}\right) = GHG\ EF_{base} - GHG\ EF_{ATV}$$

Where:

- **GHG ER$_{\mathbf{annual}}$** is the annual GHG emission reductions that are associated with the proposed project;

- **GHG EF_{base}** is the GHG emission factor associated with the base case vehicle or equipment that the advanced technology vehicle or equipment is compared against; and
- **GHG ER_{ATV}** is the GHG emission factor that is associated with the proposed advanced technology vehicle.

$$Project\ GHG\ ER_{annual} = \left(257\frac{metric\ tons\ CO2e}{year}\right) - \left(251\frac{metric\ tons\ CO2e}{year}\right)$$

$$= 6\frac{metric\ tons\ CO2e}{year}$$

Step 5: Determine the annual criteria pollutant emissions that are associated with the baseline vehicle. The baseline vehicle is using a 300 hp diesel engine that is certified to the Tier 4 Final emissions standard, therefore, using emission values from Table IV-7 and fuel consumption rate factors from Table IV-19, populate Formula 13. The vehicle will be used 100% of the time in California.

For a Tier 4 Final off-road engine at 300 hp, Table IV-7 gives criteria pollutant emissions per bhp-hr and Table-24 gives the fuel consumption rate factors. Therefore:

NOx = 0.26 $\frac{g\ NOx}{bhp-hr}$; ROG = 0.06 $\frac{g\ ROG}{bhp-hr}$; PM10 = 0.008 $\frac{g\ PM10}{bhp-hr}$

Formula 13:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

$$Annual\ ER_{NOx} = \left(0.26\frac{g\ NOx}{bhp-hr}\right) * \left(18.5\frac{bhp-hr}{gal\ diesel}\right) * \left(18{,}750\frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.099\frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.06\frac{g\ ROG}{bhp-hr}\right) * \left(18.5\frac{bhp-hr}{gal\ diesel}\right) * \left(18{,}750\frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.023\frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(0.008\frac{g\ PM10}{bhp-hr}\right) * \left(18.5\frac{bhp-hr}{gal\ diesel}\right) * \left(18{,}750\frac{gal\ diesel}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.003 \frac{tons\ PM10}{year}$$

Step 6: Determine the annual criteria pollutant emissions that are associated with the advanced technology vehicle. The vehicle is using a 300 hp diesel engine that is certified to the Tier 4 Final emissions standard, therefore, using emission values from Table IV-7, fuel consumption rate factors from Table IV-19, and the result of Step 2 above to populate Formula 13. The vehicle will be used 100% of the time in California.

Formula 13:

Annual Emission Reductions =

*Emission Factor or Converted Emission Standard (g/bhp-hr) * fuel consumption rate factor (bhp-hr/gallon (gal)) * Activity (gal/yr) * Percent Operation in CA * ton/907,200g*

$$Annual\ ER_{NOx} = \left(0.26 \frac{g\ NOx}{bhp-hr}\right) * \left(18.5 \frac{bhp-hr}{gal}\right) * \left(18{,}280 \frac{gal}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.097 \frac{tons\ NOx}{year}$$

$$Annual\ ER_{ROG} = \left(0.06 \frac{g\ ROG}{bhp-hr}\right) * \left(18.5 \frac{bhp-hr}{gal}\right) * \left(18{,}280 \frac{gal}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.022 \frac{tons\ ROG}{year}$$

$$Annual\ ER_{PM10} = \left(0.008 \frac{g\ PM10}{bhp-hr}\right) * \left(18.5 \frac{bhp-hr}{gal}\right) * \left(18{,}280 \frac{gal}{year}\right) * (1) * \left(\frac{1\ ton}{907{,}200\ grams}\right)$$

$$= 0.003 \frac{tons\ PM10}{year}$$

Step 7: Determine the weighted annual emissions reductions that are associated with the proposed project. Using the results from Step 5 and Step 6 above, populate Formula 11.

Formula 11:

Annual Weighted Surplus Emission Reductions =

*NOx reductions (tons/yr) + ROG reductions (tons/yr) + [20 * (PM reductions (tons/yr)]*

$$WER = \left(0.099 - 0.097 \frac{tons\ NOx}{year}\right) + \left(0.023 - 0.022 \frac{tons\ ROG}{year}\right) + \left(20 * (0.003 - 0.003) \frac{tons\ PM}{year}\right)$$

$$= 0.003\ \frac{tons}{year}$$

Step 8: Determine the incremental cost of the proposed technology using Formula 10 and the equipment costs for the baseline and advanced technology vehicle given at the start of this example. Cost-effectiveness is to be calculated for two scenarios; for two years during the demonstration and for 10 years, two years after the completion of the demonstration project.

Baseline Equipment:
- Top handler cost at demonstration: $550,000
- Top handler cost two years after demonstration: $550,000

Advanced Technology:
- Top handler with logistic technology cost at demonstration: $590,000
- Top handler with logistic technology two years after demonstration: $575,000

Formula 10:

Incremental Cost = Cost of New Technology ($) – Cost of Baseline Technology ($)

Incremental Cost$_{2\ years}$ = $590,000 – $550,000 = $40,000

Incremental Cost$_{10\ years}$ = $575,000 – $550,000 = $25,000

Step 9: Determine the GHG emission reduction cost-effectiveness for the proposed project using Formula 5 and the results from Step 4 and Step 8.

Formula 5:

$$Cost\ Effectiveness\ \left(\frac{\$}{metric\ ton\ CO2e}\right) = \frac{CRF * incremental\ cost}{Project\ GHG\ ER_{annual}}$$

Where, for the purposes of this Solicitation:
- **CRF** is the Capital Recovery Factor;
- **CRF$_2$ = 0.515**, per Moyer Table G-3a (2-year life);
- **CRF$_{10}$ = 0.111**, per Moyer Table G-3a (10-year life); and
- **Incremental cost** is the difference between the cost of the baseline vehicle or equipment and the advanced technology vehicle or equipment.

$$GHG\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$40{,}000)}{\left(6 \frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$3{,}433\ per\ metric\ ton\ CO2e\ reduced$$

$$GHG\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$25{,}000)}{\left(6\,\frac{metric\ tons\ CO2e}{year}\right)}$$

$$= \$463\ per\ metric\ ton\ CO2e\ reduced$$

Step 10: Determine the criteria pollutant cost-effectiveness for the proposed technology. Use the results from Step 7 and Step 8 to populate Formula 8.

Formula 8:

Cost-Effectiveness ($/ton) = Annualized Cost ($/year) / Annual Weighted Surplus Emission Reductions (tons/year)

$$WER\ Cost\ Effectiveness_{2\ years} = \frac{(0.515 * \$40{,}000)}{\left(0.003\ \frac{tons\ WER}{year}\right)}$$

$$= \$6{,}867{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

$$WER\ Cost\ Effectiveness_{10\ years} = \frac{(0.111 * \$25{,}000)}{\left(0.003\ \frac{tons\ WER}{year}\right)}$$

$$= \$925{,}000\ per\ ton\ weighted\ criteria\ pollutants\ reduced$$

APPENDIX E

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS AND THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) COMPLIANCE AND PERMITTING REQUIREMENTS

Mobile Source Control Division
California Air Resources Board
June 9, 2017

California Environmental Protection Agency

Air Resources Board

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Each proposed infrastructure installation (e.g., electric vehicle supply equipment or hydrogen refueling station) may be subject to California Environmental Quality Act (CEQA) compliance, as well as permitting and other requirements. Such proposals must adhere to the requirements specified in this Appendix.

I. CEQA COMPLIANCE INFORMATION

The California Environmental Quality Act (CEQA) requires public agencies to identify the significant environmental impacts of their actions and to avoid or mitigate them, if feasible. Under CEQA, an activity that may cause either a direct or reasonably foreseeable indirect physical change in the environment is generally considered a project. An activity funded by a grant may be considered a project under CEQA if it will cause a direct or reasonably foreseeable indirect physical change in the environment. Agencies must comply with CEQA before they approve a project. For projects which are exempt from CEQA, agencies may prepare a Notice of Exemption (an example is provided for reference).

Before applicants submit an application, applicants must be certain that the project is eligible for a CEQA exemption. Due to the limited expenditure timeframes involved in this solicitation, projects that are not categorically exempt will not be eligible for funding. Applicants must complete a CEQA Worksheet (Appendix A, Attachment 7) for each proposed infrastructure installation. The Air Resources Board (CARB or Board) must ensure that the appropriate level of environmental review under CEQA is complete prior to approval. Thus, no grant can be approved, nor can any grant be executed, until the Lead Agency has determined that the project is exempt from CEQA requirements, or the CEQA requirements have been satisfied.

As part of its application, the Applicant shall provide a detailed description of the project and all of its components, as well as any direct physical changes and reasonably foreseeable indirect changes to the surrounding environment. Because of CARB's role as a CEQA responsible agency (see section D below), CARB needs detailed information from project applicants about the project's components in order to properly evaluate each grant application under CEQA. In order to minimize or avoid adverse environmental impacts, CARB will only accept applications for proposed projects to be sited where similar infrastructure already exists (e.g., installing electric vehicle supply equipment where electrical infrastructure already exists, or installing a hydrogen refueling station at an existing fueling station or industrial facility).

Applicants must provide documentation from the local lead agency showing the CEQA process has been completed. Documentation such as a letter from the local agency acknowledging their role in the CEQA process, a permit application to the lead agency that is stamped as received, or a completed notice of exemption, If no CEQA review is required by a local lead agency, provide documentation from the local lead agency explaining why not.

The Applicant must provide the following information as it pertains to the proposed project:

A. Proposed Station Location: The Applicant must provide the specific address or equivalent location information for the proposed station, equipment, fill system(s), and/or dispensing unit(s).

B. Permits: The Applicant must identify the permits necessary for the project with the proposal narrative.

C. Project Impacts: The Applicant must describe the direct physical changes and reasonably foreseeable indirect changes to the surrounding environment that may result from the project. Please see Section 3 of Attachment 7 to Appendix A.

D. CEQA Lead Agency: The lead agency is the public agency that has the greatest responsibility for carrying out or approving a project and for preparing environmental review documents under CEQA. Where the award recipient is a public agency, the lead agency is typically the grantee. Where the award recipient is a private entity, the lead agency is the public agency that has the greatest responsibility for approving the project as a whole. When awarding grants, CARB is typically a Responsible Agency under CEQA, which means that it must make a CEQA finding based on review of the funded activities and any environmental documents created by the lead agency. The lead agency will be identified using the following process.

1. Where the proposed project would require a discretionary approval from another permitting agency, the Applicant must identify the CEQA lead agency in the application and include documentation demonstrating that contact has been made with the lead agency with jurisdiction over the project for purposes of complying with CEQA. The documentation may be in the form of a letter from the lead agency that is stamped as received by the local agency.

2. If CARB is the only agency with discretionary approval over the proposed project, then ARB will act as the lead agency and will work with the Applicant to satisfy CEQA requirements.

3. Regardless of which agency is the lead agency for a proposed project, the Applicant shall be responsible for all costs associated with preparation of environmental review documents. The Applicant may also be required to retain a consultant to perform environmental studies as appropriate. CARB ***WILL NOT*** reimburse any Applicant for these costs.

E. CEQA Compliance Where the Proposed Project Would require a Discretionary Approval From Another Permitting Agency (i.e., another agency serves as the Lead Agency):

1. **Exempt Projects:** If the lead agency determines that the proposed project is exempt from CEQA or is not a “project” for purposes of CEQA, the Applicant must submit proof of such a determination as well as a legally adequate, properly filed Notice of Exemption or proof that more than 180 days have elapsed since the agency’s decision to carry out or approve the project to CARB prior to grant execution. Additionally, the Applicant must provide detailed information on why the

project meets the applicable statutory or categorical exemption and why no exceptions to the categorical exemptions apply (see CEQA guidelines section 15300.2). The Applicant shall provide facts sufficient to support the lead agency's conclusion. For example, for a Class One Categorical Exemption (California Code of Regulations (CCR), Title 14 § 15301), the Applicant should provide documentation showing that the project is located at an existing facility that involves negligible or no expansion of an existing use.

i. Ministerial or "Common Sense" Exemptions: If the lead agency exempts a proposed project under the "ministerial" or "common sense" exemptions (CCR, Title 14, § 15268 and § 15061, subd. (b)(3), respectively), the Applicant shall provide details on whether the project meets some other statutory or categorical exemption. For example, the Applicant should not simply state that a 100% renewable hydrogen project is exempt under the common sense exemption.

2. If an Applicant fails to timely submit the required CEQA documentation as described above, CARB its sole discretion may cancel the proposed grant and make a selection to the next-highest scoring project, and so on, until an agreement is reached, or exercise its right, in its sole discretion, throughout this process to not award a grant. CARB reserves the right, in its sole discretion, to cancel this solicitation, re-solicit for a Grantee, or to direct funding to another project in the Funding Plan.

3. In accordance with CEQA requirements, CARB will review each project application and consider the facts and circumstances of each project application (including the project's reasonably foreseeable direct and indirect impacts) before determining whether the lead agency's CEQA review findings and documentation are adequate.

F. CEQA Compliance Where the Proposed Project Would Not Require a Discretionary Approval From Another Permitting Agency: If CARB is the only agency with discretionary approval over the proposed project, then CARB will act as the lead agency and will work with the Applicant to satisfy CEQA requirements. The applicant must provide CARB with detailed information regarding the project description, why the project would qualify for any CEQA exemptions, and why no exceptions to those exemptions would apply pursuant to CEQA Guidelines section 15300.2. In accordance with CEQA requirements, CARB will review each project application, and consider the facts and circumstances of each project application (including the project's reasonably foreseeable direct and indirect impacts) before determining the level of required environmental review.

G. Other Relevant CEQA Information: The Applicant shall submit any other relevant CEQA documentation or information that will assist CARB in confirming CEQA compliance.

Within a proposal, the applicant is encouraged to fully document efforts completed or underway to achieve CEQA compliance. This includes, but is not limited to, CEQA compliance documentation, completed or schedule pre-application meetings with the local CEQA lead agency, or documentation of contact with CEQA lead agency.

NOTE REGARDING ENCUMBRANCE DEADLINES AND DISCLAIMER: The funds under this solicitation have strict encumbrance deadlines. The lead agency (which may be CARB if no other local discretionary approval is required) must complete environmental review under CEQA and approve each grant prior to the applicable encumbrance deadline. Thus, if a project cannot complete CEQA review in time to meet the applicable encumbrance deadline, **CARB reserves the right to cancel the proposed grant and recommend funding the next highest scoring project that can meet the encumbrance deadline,** regardless of the Applicant's diligence in submitting CEQA information and materials. Further, CARB is not liable for any costs incurred during environmental review or as a result of cancelling the proposed grant.

II. PERMITTING

The Applicant must include information in their narrative that describes their plans to obtain permits for each proposed infrastructure installation. The Governor's Office of Business and Economic Development is available to provide permitting assistance. Contact information is available below:

Mr. Tyson Eckerle
Zero-Emission Vehicle Infrastructure Project Manager
Office of Business and Economic Development
1400 Tenth Street, 2nd Floor
Sacramento, CA 95814
Phone: 916-322-0563
Fax: 916-322-0693
Email: tyson.eckerle@gov.ca.gov

III. PHOTOGRAPHIC EVIDENCE OF THE STATION LAYOUT

The Application must provide photographic images with both date and time stamps of all intended locations. The images must show the station ingress and egress.

IV. EXAMPLE NOTICE OF EXEMPTION

Notice of Exemption

To: Office of Planning and Research
P.O. Box 3044, Room 113
Sacramento, CA 95812-3044

From: Grantee
101 Main Street
Ventura, CA 93003

Project Title: Zero Emission Transit Project

Project Applicant: Company Zero

Project Location - Specific:
742 Evergreen Terrace, Ventura, CA 93003

Project Location - City: Ventura Project Location - County: Ventura

Description of Nature, Purpose and Beneficiaries of Project:
Company Zero will design, develop, and operate an all-electric, zero-emission, public transit buses in the city of Ventura. Project will install ten Level II EVSE in the adjacent parking lot of the existing site to support charging of the buses. The project will reduce production costs and accelerate the deployment of zero-emission, public transit buses throughout the State. The project will also leverage public funds with private capital to provide high paying jobs that will contribute to the local economy.

Name of Public Agency Approving Project: City/County/Air Districts, etc.

Name of Person or Agency Carrying Out Project: City and County of Sacramento

Exempt Status: **(check one):**

- ☐ Ministerial (Sec. 21080(b)(1); 15268);
- ☐ Declared Emergency (Sec. 21080(b)(3); 15269(a));
- ☐ Emergency Project (Sec. 21080(b)(4); 15269(b)(c));
- ☒ Categorical Exemption. State type and section number: 14 C.C.R. sects. 15301, 15303, 15304
- ☐ Statutory Exemptions. State code number: ___

Reasons why project is exempt:

The project consists of minor alteration of existing facilities and mechanical equipment involving negligible or no expansion of the facility beyond that existing. Interior modification work includes installation of manufacturing equipment inside the existing building. Work on the fast charging system includes installation of conduit, wiring, electrical connections and mounting equipment. Minor trenching is required to bring power to the charging system. The project will not impact surrounding residential areas, traffic or right of way, or noise impacts because the project is located in an industrial area zoned for industrial use. The reconstruction and conversion of small structures for this project will not impact the scenic resources because the project is industrially zoned.

Lead or Responsible Agency

Contact Person: ___________________________ Area Code/Telephone/Extension: ___________________________

If filed by applicant:

1. Attach certified document of exemption finding.
2. Has a Notice of Exemption been filed by the public agency approving the project? ☐ Yes ☐ No

Signature: ____________________________ Date: ______________ Title: ________________________________

☒ Signed by Responsible Agency

☐ Signed by Lead Agency Date received for filing at OPR: _____________________________

☐ Signed by Applicant

APPENDIX F

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS AND THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

DATA COLLECTION REQUIREMENTS

Mobile Source Control Division
California Air Resources Board
June 9, 2017

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

California Environmental Protection Agency
Air Resources Board

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Table F-1 below lists the minimum requirements for data collection elements to be collected as part of a project requesting funding under this solicitation; additional data may be collected beyond what is presented below.

Table F-1. Minimum Data Items: Off-Road Vehicle/Equipment

Vehicle / Equipment Specification
• Vehicle specification (e.g., manufacturer, model, model year, gross vehicle weight, fuel capacity etc.). • Full propulsion system specification, including legible engine label photos.
Vehicle / Equipment Operation
• Vehicle usage, e.g., hours of operation per day, days of operation per year, odometer reading. • GPS data (must be able to distinguish between key off and key on but not moving) if vehicles are operated outdoors. • General description of daily use of vehicles/equipment. • Duty cycle logging and load analysis. • Average speed and idling time (if not already captured in the duty-cycle logging, also applicable to yard trucks). • Odometer reading (beginning and end of each shift, also applicable to yard trucks). • Measure or estimate the weight of each load/lift (applicable to forklifts and top handlers); weight of load per container moved (applicable to yard trucks). • Workflow modifications with advanced technology vehicles/equipment, if any.
Vehicle / Equipment Performance
• Performance during normal work week vs. peak (i.e., holiday, overtime, double shift, high temperature or low temperature etc.). • Vehicle productivity/performance profile (acceleration, lift/lower speed, ramp speed) – beginning (full battery/tank) vs. end of shift (low battery/tank). • Comparison of an appropriate productivity metric with advanced technology vs. baseline vehicles (i.e., forklift/lifting equipment: pallets moved per shift or day; yard tractor: container pulls per shift or hour). • Battery degradation (battery charge capacity/power output over the length of the project).
Fuel / Energy Consumption
• Amount of fuel/electricity; date; fuel price per unit when a vehicle/equipment is fueled (include electricity rates as applicable). • State of charge (SOC) throughout work shift (minute-by-minute), if applicable. • Refueling time/charging time. • Distance traveled to refuel/charge if fueled off-site. • Refueling/charging source (e.g., on-site energy storage, grid, delivery, etc.). • Off-peak and/or renewable energy load shifting potential (e.g., battery recharging optimization with smart meter). • Refueling/charge frequency. • Fuel efficiency, energy consumption rate per work completed/distance driven and Fuel/energy consumption while idling (if applicable).

Maintenance
• List of systems for both baseline and advanced technology vehicles/equipment for which preventative maintenance is regularly scheduled and anticipated frequency of scheduled maintenance. • Type of maintenance: scheduled and unscheduled. • Repairs: date, description of problem, description of repair performed, parts replaced, costs of parts replaced, costs of labor. • Time out of service with an explanation of reason for any extended delay.
Service Calls
• Date of service call, description of problem, description of repair performed, parts replaced, odometer reading. • Time out of service. • Service response time to new trouble call.
Safety
• Description of any accidents or incidents, including collisions, maintenance and fueling incidents.
Emissions Testing
• Tailpipe emissions test for vehicles/equipment that are not 100% zero emission, and their respective baseline vehicles/equipment using PEMS technology.
Fueling / Charging Infrastructure and Maintenance Infrastructure
• Infrastructure facility description, including station throughput/capacity, for both fueling/charging station and maintenance bay. • Infrastructure reliability.
Capital Costs
• Capital costs for advanced technology vehicles and baseline vehicles, or cost of vehicle upgrade. • Infrastructure/facility capital costs or cost of facility modification/upgrade, for both fueling/charging station and maintenance bay.
Operating and Maintenance Costs
• Detailed operating costs for both baseline and advanced technology vehicles/equipment. • Detailed maintenance costs for both baseline and advanced technology vehicles/equipment, including parts and labor (total labor cost and mechanic labor cost in $/hour). • Fueling infrastructure and maintenance infrastructure O&M costs (e.g., type of maintenance, costs for parts and labors, problems). • O&M costs for facility safety systems related to hydrogen and fuel cells (e.g., type of maintenance, costs for parts and labors, problems), if applicable.

User / Fleet Experience Survey
• User/fleet experience of the advanced technology vehicles/equipment, e.g., vehicle availability, power, capacity to meet fleet operation demand, O&M challenges, service parts availability, perceived safety, refueling experience and any barriers. • Describe the workforce training programs, if any, related to the use and maintenance of the advanced technology vehicles. Evaluate the effectiveness of such programs and the costs associated with them. • Describe warranty claims and insurance policies, as well as the experience of working with vehicle/equipment manufacturers in the instance of an accident or a major period of unexpected down time (as applicable). • The vehicle manufacturer response/service for warranty claims and/or trouble shooting.

THE PORT OF LOS ANGELES
425 S. Palos Verdes Street Post Office Box 151 San Pedro, CA 90733-0151 TEL/TDD 310 SEA-PORT www.portoflosangeles.org

Eric Garcetti | *Mayor, City of Los Angeles*
Board of Harbor Commissioners | Ambassador Vilma S. Martinez, *President* | David Arian, *Vice President* | Patricia Castellanos | Anthony Pirozzi, Jr. | Edward R. Renwick
Eugene D. Seroka | *Executive Director*

September 6, 2017

Jack Kitowski, Chief
Mobile Source Control Division
California Air Resources Board
Mobile Source Control Division
9528 Telstar Avenue
El Monte, CA 91731

Dear Mr. Kitowski:

SUBJECT: OFF-ROAD ADVANCED TECHNOLOGY DEMONSTRATION PROJECTS APPLICATION

The City of Los Angeles Harbor Department (Harbor Department) is pleased to submit the attached application in response to the California Air Resource Board's Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program for Off-Road Advanced Technology Demonstration Projects. The Harbor Department's *Zero-Emissions Track-Miles Locomotive Demonstration Project* presented in this application will provide a comprehensive nine-month in-service demonstration of a zero-emissions-capable switcher locomotive handling rail cargo within the Ports of Los Angeles and Long Beach (Ports).

The Harbor Department is proposing to demonstrate a zero-emission track-mile switcher locomotive in the Ports, in partnership with VeRail Technologies, Pacific Harbor Line, the South Coast Air Quality Management District, the Los Angeles Department of Water and Power, and the Coalition for a Safe Environment. The project would demonstrate the VeRail VR21C-Z, a zero-emission battery-powered switcher locomotive design, capable of supporting the 2,100 horsepower requirements for full operational capability throughout the PHL network of in-harbor track lines. This demonstration will take place within the Ports and the adjacent disadvantaged communities of Wilmington, San Pedro, and Long Beach. With speeds of 10-15 miles per hour (mph) within the Ports and 35-40 mph on the Alameda Corridor, the PHL duty cycle for locomotives is the "Mount Everest" of switcher duty cycles, as typical switcher operations rarely exceed 10 mph. The 14-pod battery bank, rated at 1,820 kW-hours, will supply enough energy for a typical eight (8) hour working period without charging. Electric charging infrastructure will be installed to support the demonstration unit at the PHL facility in Wilmington, CA.

AN EQUAL EMPLOYMENT OPPORTUNITY - AFFIRMATIVE ACTION EMPLOYER

Printed on recycled paper

The total project cost is $3,858,037 and the Harbor Department requests grant funding in the amount of $2,793,717 to co-fund the demonstration project. The project partners are providing 27 percent, or $1,064,320 in match funding ($892,371 cash and $171,949 in-kind), as indicated in the attached letters of support. The Harbor Department's project management team will provide all in-house support as an in-kind contribution to this important project.

Thank you for the opportunity to submit a proposal for this innovative project that will reduce dependence on foreign oil and emissions of greenhouse gas, smog, and toxic particulates. Please contact me at 310-732-3763 or via email at ccannon@portla.org, if you have any questions.

Sincerely,

CHRISTOPHER CANNON
Director of Environmental Management

CC:LW:TD:JG:mrx

Attachment

APPLICATION

to the

LOW CARBON TRANSPORTATION AND FUELS INVESTMENTS
AND
THE AIR QUALITY IMPROVEMENT PROGRAM

Fiscal Year 2016-17
Off-Road Advanced Technology Demonstration Projects

for

Port of Los Angeles Zero-Emission Track-Miles Locomotive Demonstration

TABLE OF CONTENTS

APPLICATION

STATE OF CALIFORNIA
California Environmental Protection Agency
AIR RESOURCES BOARD
MSCD/ISB/AQIP_97 (Rev. 08/13)

ADVANCED TECHNOLOGY DEMONSTRATION PROJECT APPLICATION

Please print clearly or type all information on this application.

1. Project: **POLA Zero-Emission Track Miles Locomotive Demonstration**
2. Company Name/Air District/Organization Name/Individual Name: **Los Angeles Harbor Department**
3. Business Type: **Government Agency**
4. Contact Name and Title: **Christopher Cannon, Chief Sustainability Officer**
5. Person with Contract Signing Authority (if different from above)/Air Pollution Control Officer (APCO): **Eugene S. Seroka**
6. Mailing Address and Contact Information:

Street: **425 S. Palos Verdes St.**

City: **San Pedro**	State: **CA**	Zip Code: **90731**
Phone: (**310**) **732-3763**	Fax: (**310**) **547-4643**	

Email: **CCannon@portla.org**

☑ I have read and understood the terms and conditions of the Sample Grant Agreement.

I hereby certify under penalty of perjury that all information provided in this application and any attachments are true and correct.

Printed Name of Responsible Party or APCO: **Eugene S. Seroka**	Title: **Executive Director**
for Signature of Responsible Party or APCO: Michael DiBernardo	Date: 9/6/17

Third Party Certification (if applicable)
I have completed the application, in whole or in part, on behalf of the applicant.

Printed Name of Third Party:	Title:
Signature of Third Party:	Date:
Amount Being Paid for Application Completion in Whole or Part:	Source of Funding to Third Party:

A-1

ATTACHMENT 1: PROJECT EXECUTIVE SUMMARY & PROJECT SUMMARY FOR PUBLIC POSTING

Executive Summary

Project Title: Zero-Emission Track-Miles Locomotive Demonstration Project.

Applicant: Los Angeles Harbor Department

Technology Demonstrator: Pacific Harbor Line

Data Collection and Analysis: Tetra Tech, CE-CERT

Advisors/Partners: SCAQMD, LADWP, CFASE

Funding Request: $2,793,717

Funding Match: $1,064,320

Project Description

The Harbor Department, VeRail Technologies and Pacific Harbor Line (PHL) are partnering with the South Coast Air Quality Management District (SCAQMD), the Los Angeles Department of Water and Power (LADWP), and the Coalition for A Safe Environment (CFASE) to demonstrate the first switcher locomotive to operate zero-emission track-miles throughout the Ports of Los Angeles and Long Beach. The Harbor Department proposes demonstration of VeRail's zero-emission battery powered switcher locomotive technology, designed to support the 2,100 horsepower requirements for full operational capability throughout the PHL network of in-harbor track lines. With speeds of 10-15 miles per hour (mph) within the port and 35-40 mph on the Alameda Corridor, the PHL duty cycle for locomotives is the "Mount Everest" of switcher duty cycles, as typical switcher operations rarely exceed 10 mph. The advanced technology 14-pod battery bank is rated at 1,820 kW-hours, and will supply enough energy for a typical working shift (8.5-12 hours) without re-charging. The zero-emission technology will be demonstrated on VeRail's Near-Zero Emissions Locomotive, which is currently undergoing evaluation as part of a Port Technology Advancement Program (TAP) demonstration project with SCAQMD, US EPA and the Port of Long Beach. Electric charging infrastructure will be installed to support the demonstration unit at the PHL facility in Wilmington, CA. The total project cost is $3,858,037, with project partners providing 27.6%, or $1,064,320 in match funding ($892,371 cash and $171,949 in-kind). PHL headquarters is located at 705 North Henry Ford Avenue, Wilmington, CA and the demonstration unit will operate in revenue service throughout the Ports of Los Angeles and Long Beach.

Project Objectives

The proposed demonstration will encompass a nine-month in-service demonstration that will be monitored by an independent third-party data collection and analysis contracting team consisting of Tetra Tech and UCR College of Engineering, Center for Environmental Research and Technology (CE-CERT). Key project objectives include:

- Meet goals under the Off-Road Advanced Technology Demonstration Project Solicitation and the FY 2016-17 Funding Plan, as described in Attachment 2, part 3, Project Objectives;
- Conduct an in-service demonstration of battery-powered switcher locomotive operation;
- Collect and evaluate demonstration data, including performance metrics and costs;
- Assess and project long-term battery life and range;
- Assess cost effectiveness based on real-world results and costs (maintenance, capital and operational), to support wider scale commercialization.

Project Benefits, Outcomes and Cost Effectiveness

Successful implementation of this project will demonstrate the technical feasibility of zero-emission switcher locomotive service in rigorous goods movement operation. Benefits are expected to include:

- Direct localized emission reductions in designated disadvantaged communities;
- Leap to zero-emission technology for a new class of off-road goods movement equipment;
- Ten-year project cost-effectiveness of $240 per metric tonne CO_2e and $80,610 per weighted reductions (tons per year) of toxic and criteria pollutants;
- Annual emission reductions are estimated in tons per year (tpy) to be: 0.888 tpy NO_x, 0.109 tpy ROG, 0.019 tpy PM_{10} and 462.31 metric tonnes per year of CO_2e (78% GHG reduction).

Project Summary for Public Posting

The Harbor Department, VeRail Technologies and Pacific Harbor Line (PHL) are partnering with the South Coast Air Quality Management District (SCAQMD), the Los Angeles Department of Water and Power (LADWP) and the Coalition for a Safe Environment (CFASE) to propose the demonstration of the first switcher locomotive to operate zero-emission track-miles throughout the Ports of Los Angeles and Long Beach. The Harbor Department requests $2,793,717 in California Climate Investment Program funding to co-fund the "*Port of Los Angeles Zero-Emission Track-Miles Locomotive Demonstration Project*". For this project, the Harbor Department proposes to demonstrate VeRail's zero-emission battery powered switcher locomotive technology, designed to support the 2,100 horsepower requirements for full operational capability throughout the PHL network of in-harbor track lines. With speeds of 10-15 miles per hour (mph) within the port and 35-40 mph on the Alameda Corridor, the PHL duty cycle for locomotives is the "Mount Everest" of switcher duty cycles, as typical switcher operations rarely exceed 10 mph. The advanced technology 14-pod battery bank is rated at 1,820 kW-hours, and is designed to supply enough energy for a typical working shift (8.5 to 12 hours) without re-charging. Electric charging infrastructure will be installed to support the demonstration unit at the PHL facility in Wilmington, CA. The total project cost is $3,858,037, with project partners providing 27.6%, or $1,064,320 in match funding ($892,371 cash and $171,949 in-kind). PHL headquarters is located at 705 North Henry Ford Avenue, Wilmington, CA and the demonstration unit will operate in revenue service throughout the Ports of Los Angeles and Long Beach. Projected key benefits include:

- Successful implementation of this project will serve as a catalyst for change in the San Pedro Bay Port complex, demonstrating the technical feasibility of zero-emission switcher locomotive service in rigorous goods movement operation.
- Direct localized emission reductions in designated disadvantaged communities, including those in zip codes 90744, 90802, 90731, 90831 and 90813
- Ten-year project cost-effectiveness of $240 per metric ton CO_2e and $80,610 per weighted reductions on NOx, ROG and PM10.
- Based on ARB's methodology in Appendix D, annual emission reductions (surplus to a Tier 4 diesel locomotive), for the proposed project are estimated in tons per year (tpy) to be: 0.888 tpy NOx, 0.109 tpy ROG, 0.019 tpy PM10 and 462.31 metric tonnes per year of CO_2e (78% GHG reduction). Actual emissions reductions that would result from implementation of the proposed technology across the PHL fleet are much greater than estimated here, since the PHL fleet does not currently consist of Tier 4 locomotive technology.

ATTACHMENT 2: PROJECT NARRATIVE AND WORK PLAN

Project Narrative

The City of Los Angeles Harbor Department (Port, Harbor Department, POLA) requests $2,793,717 from the California Air Resources Board's Off-Road Advanced Technology Demonstration Projects funding, to conduct the Zero-Emission Track-Miles Locomotive Demonstration, which is summarized in the table below. Industry partners are all contributing to the success of this project either financially or by providing in-kind assistance.

Project Title:	Zero-Emission Track-Miles Locomotive Demonstration	
Total Project Budget:	$3,858,037	
Funding Amount Requested:	$2,793,717	
Match Funding Total:	$1,064,320	
Match Funding Breakout:	Cash: $892,371	In-Kind: $171,949
Applicant:	Port of Los Angeles, Public Entity	
End User (Demonstration Partner):	Pacific Harbor Line (PHL)	
Industry Partners (Technology Development Team):	Pacific Harbor Line (PHL)	
	VeRail Technologies, Inc.	
	Voltabox of Texas	
	American Traction Systems (ATS)	
	TMV Control Systems (TMV)	
	Tetra Tech	
	College of Engineering-Center for Environmental Research & Technology, University of California, Riverside (CE-CERT)	
	South Coast Air Quality Management District (SCAQMD)	
	Los Angeles Department of Water and Power (LADWP)	
Community Advisor	Coalition for A Safe Environment (CFASE)	
Disadvantaged Community (DAC) Zip Codes	90744, 90802, 90731, 90831, 90813	

The proposed project builds upon and leverages the experience being gained from VeRail's existing Near-Zero Emissions Locomotive Demonstration Project, which is currently underway as part of a Port Technology Advancement Program (TAP) demonstration project with SCAQMD, US EPA and the Port of Long Beach. While the proposed project utilizes the same base locomotive unit, there is no overlap between the two projects, and no funding from the existing TAP project is being proposed as match for this new zero-emission locomotive demonstration. Further, the proposed project will not delay or otherwise interfere with the TAP project scope that is currently underway. The Harbor Department is excited about this unique opportunity to leverage an existing project to further accelerate the emissions reduction performance of advanced technology switcher locomotive technology. The value of the base locomotive unit itself is not accounted for in the match funding for this project, providing CARB an excellent value for its grant program "dollar." The total project budget is exceptionally concise, combining the initial battery and other hardware cost with the need to build supporting infrastructure and integrate the zero-emission technology into the base locomotive unit. In fact, nearly 75% of the total grant request is budgeted directly to cover the cost of the batteries, demonstrating that state funds are being used effectively and for the primary design goal of the project: zero-emission track-miles operation.

It is noteworthy that this project is scheduled as an informational item for the upcoming Board of Harbor Commissioners meeting on September 7, 2017. This educational effort will streamline the final approval process, should the Harbor Department ultimately be selected for an award under this program. A copy of this Board Report is included in Attachment 8.

1. Applicant Qualifications

- ✓ Experienced with Air Quality Incentive Programs and Technology Demonstration Projects
- ✓ AQIP grant management experience
- ✓ Top-level executive commitment for resources throughout the project
- ✓ Proposed project exceeds match requirements
- ✓ Contributing project partners include OEM, industry and community
- ✓ Robust testing platform in place for locomotives throughout the San Pedro Bay ports

The Port of Los Angeles is the nation's number one container port and a global model for sustainability and social responsibility. The Port brings extensive experience developing, implementing, and administering both large-scale air quality incentive projects and programs and technology demonstrations through its landmark Clean Air Action Plan (CAAP) and through other initiatives that support CAAP objectives. The CAAP, a joint effort with the Port of Long Beach, is a comprehensive program to reduce port-related emissions to make the region a cleaner, healthier place to live and work. The California Air Resources Board (CARB) recently awarded the Port $15 million from its Air Quality Improvement Program (AQIP) for the Port's Green Omni Terminal Demonstration project. Additionally, through this recent AQIP experience, the Port is fully aware of the detailed and active project management that is required for successful implementation of large demonstration projects and already has the tools in place to implement the proposed Zero-Emission Track-Miles Locomotive Demonstration Project, if grant funding is awarded. The proposed project has the full commitment of the Port's Executive Director and the Director of Environmental Management, ensuring that the resources will be available throughout implementation of the project at the levels necessary for success. Through the project team's existing relationships and extensive coordination with technology providers, equipment and vehicle manufacturers, equipment operators, as well as other project stakeholders, the Port has met and exceeded the match funding requirements for this project. Additionally, the Port has a robust testing platform of San Pedro Bay short-haul rail track in place to conduct rigorous demonstration testing of the locomotive over long time periods, without disruption to its goods movement system.

Experience with Large-Scale Air Quality Incentive/Technology Demonstration Projects

Green OMNI Terminal Demonstration Project – In 2016, Pasha and the Port of Los Angeles began the Green Omni Terminal Demonstration Project. The project involves testing clean energy vehicles, cargo handling equipment and infrastructure at the Pasha terminal to create a working laboratory for advancing zero and near-zero emission technologies at the Port. Additionally, Pasha will install a solar-powered microgrid with a 1.03 megawatt photovoltaic rooftop array, a 2.6 megawatt-hour battery storage system, charging equipment that can both receive and supply power and an energy management control system. This project received a $15,050,400 grant from the California Air Resources Board. To date, 50% of the funds have been received.

Advanced Yard Tractor Deployment/Eco-FRATIS Drayage Project – This project includes testing of a new fleet of 25 zero and near-zero emission yard tractors at the Everport marine container terminal in the Port of Los Angeles. Additionally, a companion project will equip 100 more drayage trucks with smart technology aimed at reducing emissions by streamlining their time on the road and improving the flow of containers to and from the port complex. This project received a $5,833,000 grant from the California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). Sub recipient agreements are nearly executed and vehicle orders are scheduled to be placed in September 2017.

Advanced Cargo Handling Demonstration Project, Everport – This project expands on existing demonstrations of zero-emission goods movement technologies by taking another step toward implementation of a zero emissions pathway for loading and unloading cargo throughout an entire marine container terminal with the demonstration of two zero-emission top handlers and three next generation yard tractors. The top handlers will be charged with standard infrastructure and the yard tractors will be "fueled" by a state of the art Automated SmartCharger System (ASCS), the first of its kind at the Port of Los Angeles. This project was awarded a $4,600,000 grant from the California Energy Commission's ARFVTP, scheduled to be considered by POLA's Harbor Commission Board for approval in October.

2. *Project Team Capabilities and Degree of Industry Collaboration*

The Harbor Department has carefully assembled an industry-leading team of technology manufacturers and industry partners to provide scalable zero-emission locomotive solutions and enhanced market acceptance for heavy-duty battery technology. As you will see in the table below, the Harbor Department has existing relationships (contractual) and work history on environmental projects with most of the key players named for this project. The Harbor Department's project partners and subcontractors include:

Key Participant	Role	Responsibilities and *Relationship to Harbor Department
Harbor Department	Applicant /Grantee	Grant Administration and Reporting, Project Leadership, Planning and Oversight of Technology Demonstration, Oversight of Data Collection and Reporting Subcontractor, Charging Infrastructure Installation Lead
Pacific Harbor Line (PHL)	End User	Equipment Operations for Demonstration, Field Demonstration Testing Rail Platform Provider, *Port of Los Angeles lease holder
VeRail Technologies, Inc.	Technology Manufacturer	Locomotive Provider *Existing contract with POLA for current TAP Demonstration Project, new contract needed for proposed project
Voltabox of Texas	Technology Manufacturer	Battery Manufacturer and Battery Technical Support *Will be a subcontractor and a supplier to VeRail.
American Traction Systems (ATS)	Technology Manufacturer	Battery high voltage control choppers and electricals *Will be a subcontractor and a supplier to VeRail
TMV Control Systems (TMV)	Technology Manufacturer	Locomotive control computer *Will be a subcontractor and a supplier to VeRail
Tetra Tech	Data Analysis Provider	Data Collection, Analysis and Reporting – Lead, proposed scope covered by existing and current contract with POLA ***Existing contract with Harbor Department**
UCR CE-CERT	Data Collection Lead and Analysis Provider	Data Collection, Analysis and Reporting – ***Subcontractor to TT, already under contract to POLA via subcontract with TT**
South Coast Air Quality Management District (AQMD)	Technical Advisor	Zero-Emission Technology Demonstration and Commercialization Advisor and direct cofounding support
Los Angeles Department of Water and Power (LADWP)	Technical Advisor	Power Supplier and Advisor *City of Los Angeles Department
Coalition for a Safe Environment (CFASE)	Community Advisor	Community Advisor to the Project Team

Technical Qualifications, Capabilities and Industry Collaboration

Below is a summary of the technical qualifications and capabilities of the project partners as well as the key personnel serving as project leads. Key personnel were selected for this team based on their ability to successfully carry out the project tasks in their areas of expertise. The partner technology manufacturers are critical members of the team, without which the Harbor Department would not be able to conduct the proposed demonstration. The technology manufacturers are established and well-respected manufacturing companies, with experienced engineering and product development professionals well-matched to this project and the proposed technical approach. The battery manufacturer, Voltabox of Texas, is a wholly owned subsidiary of Paragon AG. Voltabox is already manufacturing heavy-duty batteries on a large scale for other industries such as mining and has the capability to ramp up production for the locomotive market. Additionally, LADWP and POLA are sister city departments with a long history of working together including implementation of shore power for CARB's at berth regulation and other advanced technology program infrastructure implementation needs for zero-emission cargo handling projects. Also, POLA is collaborating with VeRail on a demonstration project being conducted through the Clean Air Action Plan TAP. Please refer to Attachment 9, Applicant Qualifications, for additional information regarding projects that demonstrate the Harbor Department's experience is well-matched to implement this proposed project. Resumes for the below individuals have been included with our Application in Appendix A to document our team's depth of experience. Below is a summary of each partner's role in the project and key personnel.

Applicant/Grantee, Grant Management and Administration Qualifications
The **Port of Los Angeles Harbor Department** is the Applicant for the Zero-Emission Track-Miles Locomotive Demonstration Project. As discussed above in subsection 1, as well as Attachment 9, Applicant Qualifications, the Port brings extensive experience developing, implementing, and administering both large-scale air quality incentive projects and programs and technology demonstration projects. The Port's extensive technology development and demonstration project experience illustrates that the collaborative efforts between the Harbor Department and equipment owners and technology providers span decades. In addition, these projects demonstrate the Harbor Department's ability to successfully implement cooperative agreements, manage resources, meet reporting requirements, evaluate projects/initiatives, and document progress. The Port's extensive history implementing grant projects from both sides (grantor and grantee) uniquely positions the Harbor Department for this proposed project in that it has both managed and implemented technology development and demonstration programs for zero-emission vehicles and equipment. Consistent with its CAAP strategies, the Port will work with its industry business partners to see these technologies through to commercialization as it will benefit all stakeholders and help the Port reach its environmental goals.

Christopher Cannon, Director, Environmental Management Division and Chief Sustainability Officer
Chris Cannon offers more than 25 years of experience in the environmental services industry, including 20 years as a technical manager of large multi-jurisdictional environmental projects. Chris has a bachelor's degree in international relations from Dartmouth College and a law degree from University of California at Berkeley's Boalt Hall School of Law. He will have overall responsibility for the success of the demonstration project, and will be supported by the Harbor Department's Environmental Management Division's Grantee Liaison/Technical Project Manager.

Jacob Goldberg, Environmental Specialist
Jacob will serve as Grantee Liaison/Technical Project Manager for this project. Jacob is the Environmental Management Division's project manager for all rail related projects in the Port. He has prior experience with grants for zero-emission goods movement projects.

Tim DeMoss, Marine Environmental Supervisor
Tim will serve as a general advisor to the project, having significant prior experience with grant funded projects.

Shaouki Aboulhosn, Senior Electrical Engineer
Shaouki has a Bachelor of Science in Electrical Engineering from the University of Washington. He will manage the engineering design and installation for the charging infrastructure.

Technology Demonstrator Qualifications

Pacific Harbor Line, Inc. (PHL) provides rail transportation, maintenance and dispatching services to the Ports of Los Angeles and Long Beach, which together form the largest container port in the United States. In addition to switching over 40,000 units of carload freight annually, PHL provides rail switching services for nine on-dock intermodal terminals and connects with Burlington Northern Santa Fe and Union Pacific railroads. As the end user, PHL will operate the locomotive throughout its San Pedro Bay network with rigorous testing during the demonstration time frame. In addition, PHL will work with the project team to maintain the equipment, train operators and maintenance staff, record and support data logging interface. PHL has an existing lease agreement with the Port of Los Angeles and works closely with the Port on goods movement issues and moving cargo through the ports in an environmentally responsible way. PHL intends to remain the nation's cleanest railroad and this commitment is in line with our support of the Ports and cities of Los Angeles and Long Beach to keep our port complex the cleanest in the world. It is a PHL goal to convert the entire locomotive fleet to near-zero and zero-emission track-miles

Otis L. Cliatt, President, PHL:

Otis has a Bachelor of Science in Business Economics and has been president of PHL for five years. He is committed to providing the resources for a successful outcome of the Zero-Emission Track-Miles Locomotive Demonstration Project.

VeRail Technologies, Inc. is the locomotive supplier for the Zero-Emission Track-Miles Locomotive Demonstration Project. VeRail Technologies was incorporated in October 2013 by thee locomotive industry veterans with a vision to move innovative green locomotive technologies forward. VeRail has already conducted significant research and development to provide the VeRail/Voltabox lithium-ion battery pod design proposed for the upcoming PHL demonstration. VeRail is the lead developer for the TAP's locomotive project that is currently underway to modify an existing diesel locomotive to a CNG-fueled locomotive (VR21C4-nz). VeRail has an existing contractual relationship with the Port of Los Angeles for demonstration of the VR21C4-nz CNG locomotive through the TAP program.

Tom Mack, President/CTO, VeRail

Tom Mack, President/CTO, brings more than 30 years of experience in industry consulting, sales, design and development and has an unparalleled knowledge of locomotives and the locomotive industry. Prior to founding VeRail, Tom was VP of Sales and Business Development for Motive Power & Equipment Solutions where he was responsible for developing new locomotive designs that meet US EPA Tier 3 and 4 standards. Tom has extensive experience in the design and development of battery powered locomotives and will bring his experience in ramping up production, increasing sales volumes, performing production testing and providing support for large-scale product volumes to this project. In 2006, Tom founded Alternative Hybrid Locomotive Technologies (AHL-TECH), a locomotive company that developed the world's first ethanol powered hybrid locomotive. Through a series of small grants, as well as private investment, from 2006 to 2011 Tom and his team at AHL-TECH developed the AHL-TECH EH-series hybrid locomotives, including the AHL-TECH EH3044-C ethanol hybrid locomotive with 1,400 HP lead acid battery system. The locomotive had two sets of 11-battery trays (22 trays in total) installed, one on each side of the locomotive.

Voltabox of Texas is a wholly owned subsidiary of paragon AG, the battery manufacturer. Voltabox is the pioneer in intrinsically safe high-performance Li-Ion batteries for all types of vehicles and stationary storage systems, with a specialization in heavy-duty applications such as locomotive and mining. Many modular battery solutions by Voltabox are in demanding, continuous use worldwide. Voltabox has made significant advancements in battery chemistry and will be supplying a nickel-Manganese-Cobalt-Oxide Lithium-Ion (abbreviated LiNMC or simply NMC) high energy cell battery technology for this demonstration project. Voltabox batteries are used around the world in heavy-duty vehicle applications, including buses, underground mining equipment, and now locomotives.

Jay Neutzler, Engineering Manager and Mechanical Engineer Voltabox
Jay will provide battery engineering for the demonstration locomotive. He has Master's degree in Mechanical Engineering and is a PhD. candidate in Mechanical Engineering at the University of South Carolina. Specializing in battery hybrid power, he is adept with characterization using Electro Impedance Spectroscopy, potentiostats, and load banks such as Gamry, Arbin, Hewlett-Packard, for R&D electrode evaluation and battery charge/discharge/cycling response.
Michael Unkelbach, Voltabox
Michael is the head of energy storage systems and electrification for Voltabox and has been working in the battery advancement field since 2009. Michael will provide battery engineering for the demonstration locomotive.

American Traction Systems (ATS) is a private, wholly American owned company specializing in the design and manufacturing of High Power AC and DC Motor Control products. ATS will provide high voltage traction control modules and high-voltage battery control modules to control the voltage and power from the battery system to the traction control modules on the demonstration locomotive.
Anthony (Tony) Davis, Ph.D, B.Sc,. A.C.G.I, M.I.E.T, American Traction Systems
Dr. Davis is a Vice President with American Traction Systems and has a degree in electrical engineering from the Imperial College of the University of London. He has over 35 years of experience in the design of power conversion equipment and the application of electronic power conversion methods to the control of electromagnetic devices. Dr. Davis will be assisting the team with high-voltage traction and battery controls on the demonstration locomotive.

TMV Control Systems (TMV) was established in 2005 to design and manufacture the next generation of locomotive control systems. TMV will be supplying the locomotive control computer. TMV is also supplying the current locomotive control computer for the VeRail CNG project and will upgrade the installed system for battery control.
Jay Rafferty, System Integration and Field Service Technician, TMV
Jay Rafferty will support the team with the locomotive control computer installation and operation. His extensive locomotive experience includes providing similar locomotive battery control systems services for Norfolk Southern. He has 17 years' experience with control systems in the locomotive and mining industries.

Data Collection and Analysis Qualifications
Tetra Tech will support the project team with the collection and analysis of performance data for this project. Tetra Tech specializes in delivering clean energy consulting and electric utility advisory services to companies, institutions, and governments worldwide, with hands-on experience collecting and analyzing data from a wide range of port equipment. Specifically, Tetra Tech has developed test plans and duty cycles, selected and installed data collection equipment, conducted emissions testing, analyzed resulting data, and prepared technical reports for several projects in the San Pedro Bay area.
Tetra Tech's experience relevant to this project includes, but is not limited to:
- PHL demonstration of the "Green Goat" battery-electric switcher locomotive
- PHL demonstration of an LNG-fueled switcher locomotive
- Technical Assistance for Alternative and Renewable Fuel and Vehicle Technology (CEC)
- Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (CARB)

Tetra Tech, as well as their subconsultant, UCR Center for Environmental Research & Technology (CE-CERT), are currently under contract with the Port of Los Angeles for miscellaneous "on-call" technical support services. Should POLA be selected for the Zero-Emission Track-Miles Locomotive Demonstration Project, POLA will issue a Project Directive (PD) with Tetra Tech/CE-CERT to serve as the independent third-party data collection and analysis subcontractor. A PD is POLA's mechanism to approve the work scope and budget for the proposed project at the staff level, with no additional contracting or Board level approvals required. In fact, the on-call/PD approach is designed to maximize POLA's agility and efficiency to leverage technical support resources.

Eddy Huang, Ph.D., Tetra Tech

Dr. Eddy Huang is a Principal Engineer and Director of the Air Quality/Clean Transportation Group at Tetra Tech. Dr. Huang brings the unique combination of air quality expertise, clean truck program experience, alternative/renewable fuel and vehicle technology experience with his large-program managerial skills to make him particularly suited to manage the project's data collection and analysis needs. He has 30 years of experience in managing air quality and clean transportation programs including the California Energy Commission's (CEC) Technical Assistance for Alternative/Renewable Fuel and Vehicle Technology Program.

Charng-Ching Lin, Ph.D., Tetra Tech

Dr. Charng-Ching Lin, a principal air quality specialist, has more than 34 years of experience in air quality and environmental compliance audit services. His technical expertise includes mobile and stationary source emissions; air pollutants and GHG emission inventory preparation, calculation, and reporting; emission abatement; and emerging technologies. He has served as the technical lead in the Port's CTP since 2008. Dr. Lin has extensive experience in large database development and management, and conducted numerous data analyses to provide critical information for policy development and decision-making. He was instrumental in developing the gate moves database and analytical algorithms for both POLA and POLB's CTP data analysis. Dr. Lin conducted vehicle emission testing on more than two million vehicles overseas using near-IR remote sensing technology. He was also involved in the GHG emission inventory and the CARB GHG Verification Programs.

UCR College of Engineering Center for Environmental Research & Technology (CE-CERT) will provide field data collection and analysis support to Tetra Tech. In recent years, CE-CERT has assisted the Harbor Department with performance evaluations of zero emission yard tractors and drayage trucks using their heavy duty truck dynamometer. CE-CERT has also completed a number of field studies to characterize vehicle emissions and field activities. Further, CE-CERT played a central role in validating portable emissions measurement systems (PEMS) used in USEPA's heavy-duty vehicle in-use testing program through the Measurement Allowance Program. As part of this program, CE-CERT conducted in-use testing validation using their Mobile Emissions Laboratory (MEL). UCR is a leading research institute in characterizing in-use emissions using PEMS and the MEL. UCR assesses light-duty vehicles, heavy-duty vehicles, construction equipment, ships, port support equipment, trains, and even jet aircraft, offering a separate PEMS system based on a Horiba PG250 portable multi-gas analyzer for steady state measurements meeting ISO 8178 requirements. UCR developed protocols to verify emission control technologies for generators, marine vessels, and rubber tire gantry cranes. CE-CERT is uniquely qualified to conduct PEMS testing for this project as well as general independent third-party data collection.

Kent C. Johnson, Ph.D., CE-CERT

Dr. Johnson has over 15 years of research specifically related to the characterization and performance of diesel engines. Dr. Johnson will support the team with field data collection and analysis for the Zero-Emission Track-Miles Demonstration project. His main responsibilities at CE-CERT include development, execution, and design of testing projects; the analysis and interpretation of test results; and the preparation of project specific data for reports and scientific articles. Projects include characterization of heavy-duty natural gas vehicles with lean burn and three-way catalyst systems; characterization and impact of 2010 compliant heavy-duty diesel vehicles and their impact on regional emissions; evaluation and characterization of heavy-duty hybrid evaluations and heavy duty electric vehicle evaluations.

The **South Coast Air Quality Management District (SCAQMD)** will be a technical advisor to the project team on development and commercialization of the zero-emission technology. SCAQMD is committed to undertaking all necessary steps to protect public health from air pollution, with sensitivity to the impacts of its actions on the community and businesses. This is accomplished through a comprehensive program of planning, regulation, compliance assistance, enforcement, monitoring, technology advancement, and public education. SCAQMD's Science and Technology Advancement Office is supporting this project with a direct cost-share contribution of $300,000, without which this project application would not have been possible.

Matt Miyasato, PhD, Deputy Executive Officer Science and Technology Advancement Office

Dr. Matt Miyasato will serve as a technical advisor to the project. He has an undergraduate degree in Mechanical Engineering, and a Masters and Ph.D. in Engineering, specializing in combustion technologies and air pollution control. Prior to SCAQMD, he worked at Southern California Edison in the Nuclear Engineering Department and at General Electric, where he designed burners and combustion modifications for utility boilers. Currently, Dr. Miyasato leads the Demonstration, Implementation, Best Available Control Technologies, and Technology Outreach groups at SCAQMD.

The **Los Angeles Department of Water and Power (LADWP)**, as the local utility servicing the Port, will advise the project team on utility connections and charging infrastructure including reviewing plans. Currently the largest municipal water and power utility in the nation, LADWP was established more than 100 years ago, and now delivers reliable, safe water and electricity to 3.8 million residents and businesses in Los Angeles. LADWP is at the forefront of renewable energy and electric vehicle (EV) development and commercialization, playing an instrumental role in developing infrastructure to prepare Los Angeles and southern California for the next generation of electric and plug-in hybrid vehicles. LADWP and POLA have closely worked together to implement CARB's at-berth shore power regulation and more recently on the Green Omni Terminal project, described earlier in Attachment 1, Subsection 1.

Tomy Giang, EV Power Distribution and Service Planning

Tomy Giang will serve as the utility technical advisor. He is an electrical engineer with LADWP's Power Engineering Division, and is responsible for EV power distribution and service planning. This includes projects for generation, substations, transmission, renewable projects, and the distribution systems as they relate to electric vehicles.

The **Coalition For A Safe Environment (CFASE)** is a community based non-profit environmental justice, public health and public safety advocacy organization. CFASE is primarily a Latino EJ Organization founded in 2001 by a Wilmington resident Jesse N. Marquez. CFASE has been a member of numerous state, regional and local governmental agency committees on ports, freight transportation, goods movement transportation corridors, air quality plans, air pollution monitoring, ship electric shorepower, emissions capture and treatment technologies. CFASE has additionally conducted its own community based scientific research on zero emission and near zero emission technologies status.

Jesse Marquez, Founder and Executive Director, Coalition for a Safe Environment (CFASE)

Jesse will serve on the project team as the community outreach advisor. He has been Executive Director of the CFASE for sixteen years.

3. Project Objectives and Work Plan

Objectives

The Zero-Emission Track-Miles Locomotive Demonstration meets all of ARB's goals under the Off-Road Advanced Technology Demonstration Project Solicitation and the FY 2016-17 funding plan by:

- **Accelerating advanced emissions reducing technologies on the cusp of commercialization into the California marketplace.** Through robust testing and careful data logging, this project will demonstrate that zero-emission battery powered locomotives, with their faster loading and acceleration, can be a cost effective and efficient solution for the goods movement industry, thus fast-tracking advanced emissions reduction technologies into the market place. Without this demonstration and testing platform, the industry would not be able to view the potential of battery power in a heavy-duty locomotive operation, including observing the operational efficiencies gained from faster loading and acceleration from zero-emission locomotives than that of currently in use pre-Tier 2 locomotives and newer Tier 2, 3, and 4 locomotives.
- **Potential for widespread commercialization and significant transformation of the industry while achieving greenhouse gas, criteria pollutant, and toxic emission reductions benefitting disadvantaged communities.** This project has the potential to be a cost-effective alternative to meet standards, thereby having the potential to enhance widespread commercialization, and subsequent transformation of the industry. Since short-haul locomotives typically (and definitely in the case of PHL) operate in and around disadvantaged communities, the benefit of zero-emission locomotives is directly relevant to those communities near port areas. Additionally, with the forecasted increase in rail activity in the San Pedro Bay ports, the use of zero-emission locomotives can have even longer term benefits.
- **Build upon advances from prior demonstration projects by expanding the type and numbers of zero emission and near-zero-emission equipment used in off-road operations and facilitating the opportunity for technology transfer from other applications.** This project closes the remaining gap in an all-electric goods movement system, from the wharf to the consumer. Advances in electric cargo handling equipment has expanded the potential for all goods movement equipment to move toward zero-emissions as the technology and charging infrastructure become supported. This project will evaluate the capabilities of zero-emission technology in one of the last remaining diesel dominant applications in goods movement: switcher locomotives.
- **Reduce GHG emissions and provide economic, environmental, and public health co-benefits to disadvantaged communities, while synergistically demonstrating the practicality and economic viability of widespread adoption of advanced off-road technologies.** This project will reduce toxic, criteria and GHG emissions from the baseline, and even further than baseline comparison if replacing older, lower tiered equipment. This technology can provide a cost-effective and scalable model for sustainable and low-emission rail operations at off-dock and near-dock railyards and marine terminals throughout the state, nation, and world.
- **This project can be implemented, demonstrated and tested by March 30, 2020.** The maturity of this project's technology combined with the proposed work plan and pre-existing relationships of the project team, ensures that the project can be completed by March 30, 2020.

Work Plan

The proposed Work Plan was developed in collaboration with our project team and is based on the Harbor Department's extensive experience designing and implementing a number of similar technology development and demonstration programs. The Work Plan is designed to ensure timely completion of all required project elements, including the technology demonstration's comprehensive data collection and emissions testing, which is based on ARB's Appendix F: Data Collection Requirements. For a detailed breakdown structure of the Work Plan, please refer to the fully developed Work Plan at the end of the Project Narrative. A summary of the tasks necessary to prepare for and conduct the project, including the lead project partner performing each task, are listed in the table below. Quantitative milestones are included in Attachment 4.

Task	Lead	Description
1.0 Administration & Project Management	Harbor Department	Administrative duties begin with a Kick-Off Meeting. Monthly project update meetings and reports will continue throughout the project and a draft of the final report will be submitted 2/14/20
2.0 Infrastructure Design & Construction	Harbor Department	Infrastructure design and construction will begin with obtaining any necessary permits, completing the infrastructure design for the charging station, construction of the charging station and testing and commissioning.
3.0 Design & Build the Demonstration Locomotive	VeRail, Voltabox, ATS, TMV	The locomotive demonstration will include completion of the locomotive design for zero-emission track mile operation, procurement of batteries and control systems, manufacturing and commissioning.
4.0 In-Service Demonstration	PHL, VeRail	The nine-month demonstration will begin 1Q 2019
5.0 Data Collection & Analysis	TetraTech, CE-CERT	Data collection and analysis will continue throughout the demonstration period.

4. Timeline for Project Completion

The project is anticipated to begin following the kick off meeting with ARB. All project components will be accomplished by March 30, 2020 as detailed in the project schedule presented at the end of the Work Plan on page 26.

5. Budget, Match Funding, and Financial Capabilities

The table below lists the tasks required to successfully complete the demonstration and the source of funding associated with each task. The total project cost is $3,858,037, with project partners providing 27.6%, or $1,064,320 in match funding ($892,371 cash and $171,949 in-kind). Each funding partner's cost share commitment is documented by a Letter of Commitment signed by an authorized representative provided in Attachment 8. No match funding is dependent on a future award under any other solicitation.

Description	Match Funding Source	Cash Match	In-kind Match	ARB Grant Request	Total
Task 1.0 Administration & Project Management	POLA				
Task 2.1 Permitting and Administration for Task 2.0	POLA	$21,246			$21,246
Task 2.2 Charging Station Installation and Power Supply Connection	POLA	$112,075			$112,075
Task 3.1a Charge Input Rectifier	ATS		$12,000		$12,000
Task 3.1b Battery Pod Design and Testing	AQMD	$75,000		$105,000	$180,000
Task 3.1c Battery Pods (13 purchase, 1 donattion)	Voltabox		$159,949	$2,079,337	$2,239,286
Task 3.1d High-Voltage Control System Development	AQMD	$75,000		$263,380	$338,380
Task 3.1e Locmotive Control Computer Upgrades	AQMD	$75,000		$56,000	$131,000
Task 3.1f Cooling Systems	AQMD	$75,000		$40,000	$115,000
Task 3.1g Battery Mounting Engineering/Testing				$250,000	$250,000
Task 3.2 Demonstration Locomotive Commissioning/Deployment	VeRail	$60,000			$60,000
Task 4.0 Demonstration	PHL	$229,050			$229,050
Task 5.0 Data Collection, PEMS and Analysis	POLA	$170,000			$170,000
Totals		**$892,371**	**$171,949**	**$2,793,717**	**$3,858,037**

6. Potential Emission Reduction Benefits

The innovative technology proposed in the Zero-Emission Track-Miles Locomotive Demonstration Project will directly help California achieve its climate change and air quality goals by reducing GHG, criteria pollutant, and toxic air contaminant emissions from the project locomotive as it operates throughout several disadvantaged communities (DAC). PHL itself is located in a designated DAC and there are four other DACs directly adjacent to PHL's operating area. PHL has indicated strong interest in expanding the zero-emission track-miles capability throughout its fleet of 23 switcher locomotives, and if successful, this project could lead to implementation at other ports throughout California and the United States. The emission reductions presented below reflect an estimate (using ARB's Appendix D methodology) of the project locomotive relative to the ARB-prescribed Tier 4 baseline, as well as a Tier 3 baseline for both a one-year of operation and for our proposed nine-month demonstration period. This table summarizes the project benefits expected from the demonstration unit.

Pollutant (per ARB Methodology in Appendix D)	Annual Reductions (tons/yr) from Tier 4 Baseline (Att. 3)	Annual Reductions (tons/yr) from Tier 3 Baseline, reflective of PHL fleet	Actual Reductions (tons/yr) during 9-month demo, vs. T3
GHG (in metric tons CO2e)	462	462	347
NOx (tons)	0.888	3.421	2.565
ROG (tons)	0.109	0.459	0.344
PM10 (tons)	0.019	0.063	0.047
Weighted Emission Redux (WER)	1.377	5.131	3.848

Upon successful completion of this project, VeRail plans to commercialize the technology throughout California and the United States. According to ARB's Technology Assessment for Freight Locomotives (November 2016)[1], there are approximately 540-640 intrastate locomotives in operation throughout California, most of which operate in switcher service. PHL has a demanding duty cycle and it would not be appropriate to simply extrapolate the estimates above to project a statewide benefit for eventual integration of the technology into the market. However, the Ports issue annual emissions inventories to estimate port operation emissions by source category (and therefore not directly comparable to the above emissions characterization based on ARB's Appendix D methodology). According to each Port's 2016 emissions inventory[2], switcher operations in 2016 resulted in the exhaust emissions tabulated below. Application of the proposed technology throughout the Ports would eliminate the emissions shown in the table below from port switcher operation.

Pollutant (Exhaust Emissions Only)	POLA, 2016 Emissions Inventory for on-port emissions	POLB, 2016 Emissions Inventory for on-port emissions	Total for San Pedro Bay Ports
GHG (in metric tons CO2e)	7,145	2,843	9,988
NOx (tons)	50.5	20	70.5
PM10 (tons)	0.5	0.2	0.7
SOx (tons)	0.07	0.03	0.1
HC (tons)	2.5	1.1	3.6

[1] *https://www.arb.ca.gov/msprog/tech/techreport/final_rail_tech_assessment_11282016.pdf*
[2] Port of Los Angeles 2016 Emissions Inventory: *https://www.portoflosangeles.org/pdf/2016_Air_Emissions_Inventory.pdf*
Port of Long Beach 2016 Emissions Inventory: *http://www.polb.com/civica/filebank/blobdload.asp?BlobID=14109*

7. Cost-Effectiveness

Please refer to Attachment 3 for a detailed, step-by-step evaluation of the cost effectiveness of the proposed project, as defined by ARB's Methodology for Determining Emission Reductions and Cost-Electiveness (Appendix D of the ARB Solicitation). Evaluation of two scenarios is required by the ARB Solicitation Appendix D:

1. The project's incremental cost at time of the demonstration, based on a two-year project life.
2. The project's incremental cost two years after completion of the demonstration, based on a ten-year project life.

The GHG and combined criteria pollutant and weighted PM emission reductions are summarized below and further detailed in Attachment 3:

$$GHG\ CE_2 = \frac{\$1,671}{metric\ ton\ CO_2e} \qquad GHG\ CE_{10} = \frac{\$240}{metric\ ton\ CO_2e}$$

$$Weighted\ CE_2 = \frac{\$561{,}002}{weighted\ tons} \qquad Weighted\ CE_{10} = \frac{\$80{,}610}{weighted\ tons}$$

8. Benefits to Disadvantaged Communities

The POLA Zero-Emission Track-Miles Locomotive Demonstration Project will be located at the PHL facility, located within a disadvantaged community at 705 North Henry Ford Avenue, Wilmington, CA 90744. The proposed project will provide environmental, social, and economic benefits to the surrounding disadvantaged communities, as detailed in Attachment 6.

9. Technology and Innovation

The technology innovation is the heavy-duty battery application for a switcher locomotive. The advanced technology design consists of a 14-pod battery bank rated at 1,820 kW-hours with enough energy to supply locomotive power for a typical shift (8.5 to 12 hours) under heavy-duty conditions without re-charging. As this demonstration will show, battery technology has made significant advances in heavy-duty applications. The demonstration conditions at PHL will be some of the most extreme in the industry as the PHL duty cycle for locomotives is the "Mount Everest" of switchers. Furthermore, the project will demonstrate the operational and commercial viability of a battery-powered locomotive in the heavy-duty switching application, helping to address concerns in the seaport industry that battery-powered equipment does not have the capacity, range, and flexibility to meet the unique operational needs of this challenging environment. The obvious advantages of this technology are 100% zero emissions capability for switcher locomotive operation. Less obvious, but equally important, is the expectation that PHL will experience operational efficiencies gained from faster loading and acceleration of zero-emission locomotives than that of its currently in use Tier 3 and 4 locomotives.

Heavy-duty applications in hazardous locations, such as the oil, gas and mining industries, require similar duty cycles combined with extreme safety procedures. These applications are potential markets for the proposed technology, should the demonstration prove successful. Furthermore, the information gained from this demonstration will be directly transferrable to medium- and high-horsepower hybrid locomotive applications, where batteries can provide a substantial amount of zero-emission track-miles but may not be capable of providing all the power required to complete a full duty cycle or meet full-throttle power requirements.

Safety Measures
Safety is being designed into the VeRail VR21C-z. Specifically, a newly designed cab addresses crew safety, comfort, and visibility beyond the original SD40-2 cab design. In addition, the battery packs are carefully designed for safety. As a battery becomes depleted, the voltage drops, the battery gets weaker and the amperage required to produce a given amount of power increases. As this occurs, there is a risk of a battery exceeding

its maximum amperage rating at the end of a shift. If the battery exceeds its power draw limits, it can overheat and this could lead to catching fire. To prevent this, an optimal battery voltage range for the VR21C-z was chosen so that even at maximum discharge (when the battery is producing its lowest voltage), the maximum amperage draw limit of the batteries is not exceeded, thus making the thermal management of the battery system easier to control, resulting in the batteries running cooler and safer. Additionally, the batteries also have internal thermal management and contactors so that if they start to get hot, they will disconnect preventing an overheat situation. The battery design also allows the use of a standard 480VAC land connection without requiring a massive charging infrastructure or expensive voltage conversion system, thus making the charging system much simpler and safer to operate and maintain.

Additionally, these battery packs are already designed and being used in hazardous job sites, such the mining industry. Heavy-duty electric vehicles used in underground mines do not require expensive ventilation systems to operate, increasing safety and lowering costs.

As an operator and a demonstrator of the equipment, safe working conditions and careful cargo handling are paramount to PHL's ongoing operations. PHL is ever-vigilant in maintaining crucial safety standards and working conditions at all times. They provide on-going safety training for management, staff, and union labor to ensure federal and state OSHA requirements are not just met, but are surpassed. Safety training on the VR21C-z will be provided to all locomotive operations and maintenance personnel. Operations and Maintenance Manuals will contain written safety instructions. A First Responder Guide will be provided to alert first responders to safety measures necessary in the event of an accident, including how to manually disconnect the battery pods from the main power bus, accessing the battery pods from outside the locomotive, and emergency cooling techniques should the battery pods overheat. While the number of pods used in the locomotive is higher than that of a standard electric car, the chemistry and technology used is similar enough that the Guide will capitalize where possible on standard practices for on-road EV emergency response.

The battery pods used in this demonstration are capable of supporting the high amperage required to provide necessary high tractive effort that is needed in heavy-duty applications. Recent advancements in battery chemistry and physical structure have made this technology work in applications where it may have previously underperformed. The battery pods being used for this demonstration are Nickel-Manganese-Cobalt-Oxide Lithium-Ion (abbreviated LiNMC or simply NMC) high energy cell. NMC is the same battery chemistry used in electric buses and cars, including the Tesla automobiles (which also use a liquid cooled battery pack). The amount of Cobalt used in these batteries is balanced to provide a high energy density while minimizing the chance of a thermal runaway. These batteries are used around the world in heavy-duty applications, including buses and underground mining equipment. In addition to the chemistry, the physical design of a battery pack ensures it can delivers a high amperage output for a long duration. This is accomplished through welded connections between the lithium-ion battery cells and secured and sealed connections to connect each battery pod to its high voltage power control module. This prevents overheating and keeps the battery performance level high.

Emissions Testing

Zero-emission equipment has no tailpipe emissions; therefore emission testing is not necessary to prove zero-emission capability. However, emission testing for comparable in-use diesel equipment is needed to ensure the quantification of reduction benefits accurately reflects the baseline emissions. As part of the ongoing TAP project, this unit will have a complete emissions evaluation for natural gas operation performed at Southwest Research Institute (since VeRail is already pursuing verification of the near-zero design). The testing results from the TAP project will provide excellent benchmark data for this project (at no additional cost!). Additionally, PEMS testing will be conducted in accordance with ARB's Appendix F requirements.

10. Potential for Market Penetration and Commercialization of the Technology

Target Markets for Zero-Emission Locomotives

Technological innovations being demonstrated through the Zero-Emission Track-Miles Locomotive Demonstration Project have broad commercialization potential at railyards in California as well as across the country and around the world. Early target markets include all railroads, both inside and outside California, that operate railyards in urban areas, especially with surrounding disadvantaged communities. PHL has expressed interest in upgrading their fleet with VeRail's locomotives once the demonstration is completed and it has been determined that the VeRail VR21C-z meets PHL's environmental and operational needs. Additionally, rail volumes are expected to grow in the future. As stated in the CAAP, the Ports of Los Angeles and Long Beach have made significant on-dock and near-dock rail investments over the years, and will continue to make investments to build rail infrastructure in the terminals and throughout the port complex, with the goal of accommodating 35% of all cargo leaving the port complex by rail. By comparison, in 2015, just 26% of all containerized cargo moving through the Ports was by rail. Over the long term, the Ports will seek to handle 50% of all cargo leaving the port complex by rail, so this is a growing market.

Another target market is the potential for growth of the "inland port" concept. The Ports have begun researching the potential of inland ports, which involve shuttling cargo by rail between the port complex and warehousing and distribution centers within 100 miles of the Ports. Initial discussions with beneficial cargo owners along with distribution center and warehouse operators indicate significant interest in an inland port served by short-haul rail to serve the Inland Empire region, provided costs are comparable to a truck move. Zero-emission locomotives could help ensure that the potential benefits of inland port locations could be realized, including reduced congestion at marine terminal gates, reduced congestion on local freeways, and reduced net emissions that do not simply entail shifting the emission source to a new location. For other regions outside of California, short haul rail opportunities are strong as well. According to the American Short Line and Regional Railroad Association, one of every four rail cars moving on the national network is handled by a "short line", providing the first and last mile for a wide variety of goods from energy products, to industrial products, to finished consumer goods. As long as consumer demand for intermodal cargo remains strong, this target segment should remain a healthy market. Short lines rely heavily on 4-axle and 6-axle locomotives in the 2,000 to 2,500 HP range, which is the exact power range being demonstrated.

Industrial locomotive operators can also benefit from this technology. In many cases, they run locomotives requiring less horsepower, but high tractive effort (pulling power). The demonstration battery pods are capable of supporting the high amperage required to provide necessary high tractive effort. In an industrial market, a lower kWh battery pack could be used because of the shorter shift times and/or lower horsepower requirements, thus making zero-emission track-miles very economical for an industrial locomotive setting. There are an estimated 7,000 industrial locomotives in service in North America, and because these tend to be the oldest locomotives in service, replacement of even a small percentage of these locomotives with zero-emission technology would provide significant emission reductions.

Barriers to Entry for Zero-Emission Locomotives

There are three major barriers to entry for battery-powered locomotive technologies. The first is the need to demonstrate long-term reliability to locomotive operators. Operators need first-hand proof that this equipment will provide uninterrupted service for its operations. Unfortunately, previous demonstrations of battery locomotives have suffered from underpowered battery packs and unsuitable battery chemistry. This has left operators wondering if a viable zero emission locomotive is even possible. The second key barrier to large-scale commercial adoption of heavy-duty battery powered locomotives is the high capital cost of the new locomotives. For example, the cost for a 6-axle battery locomotive and its associated infrastructure is typically well over $4M, more than $1M more than the $3M cost for a 6-axle locomotive Tier 4 diesel locomotive. Railroads typically do not even pay the base cost for a switching locomotive as they simply relegate older, high-maintenance line haul locomotives already in their fleet to switcher duty. The third barrier to entry in locomotive applications other than switching operations, such as line-haul operation, is operational range of the locomotives, which is limited by battery life and availability of adequate charging infrastructure along long-haul routes. This demonstration can have the positive outcome of showing how the proposed technology can also be applied to locomotives requiring longer range operations by providing data on practical ways to add enough battery power to these locomotives to benefit from zero-emission track-miles capabilities.

Commercialization Plans

The first step for commercialization of the battery-operated locomotives is to demonstrate the long-term reliability and operational efficiency improvement potential. Upon successful completion of the demonstration, VeRail plans to offer the VR21C-z locomotive for commercial sale to railroads throughout North America. The design of the 2,100 HP VR21C-z locomotive provides the same horsepower at each throttle notch as a 2,100 HP diesel locomotive. The kWh capacity of the battery system supports the normal kWh expended during operation of a 2,100 HP diesel locomotive running the EPA switcher duty cycle over an 8 hour shift. Thus, the design of the demonstration locomotive is identical to that which is planned to be commercialized and can be available for sale after a successful demonstration. If a railroad needs to run a longer, heavier duty cycle than the standard EPA switcher duty cycle, or requires extended battery life to operate a longer shift, the design of the VR21C-z locomotive allows additional 130 kWh battery "pods" to be added to the locomotive to extend operation time. (This concept of adding more battery "pods" to the base design locomotive is similar to a diesel locomotive offered with a 1,500 gallon fuel tank. If the locomotive needs to operate for a longer period of time than the fuel tank will allow, the diesel locomotive would simply be outfitted with a higher capacity 2,000 or 2,500 gallon fuel tank.) The zero-emission locomotive has thus been designed from the beginning with commercialization in mind and not just as a concept test locomotive. This locomotive design can be available for sale after a successful demonstration.

As noted earlier, VeRail is pursuing ARB verification for its near-zero locomotive design under a separate TAP project. As such, VeRail fully understands and commits to including the zero-emission design in its overall business plan to support commercialization (i.e., we know what we are getting into). Of course, this will be a collaborative effort with ARB, since there are currently no test protocols for zero-emission locomotive engines. VeRail assumes that performance and design data will be shared with ARB's verification staff, along with other data as required to support ultimate approval of the zero-emission locomotive technology.

The primary economic benefit of electrified equipment is reduced operations and maintenance costs, particularly in the form of fuel savings but also operational efficiency gains, which can offset the initial capital cost and provide a shorter payback period for the operator.

11. Application Completeness

All parties participating in the demonstration have read and agree to abide by the Sample Grant Agreement (Appendix B) and are committing to fulfill the obligations detailed in the application package.

Work Plan
The work plan will be executed in five (5) major tasks:

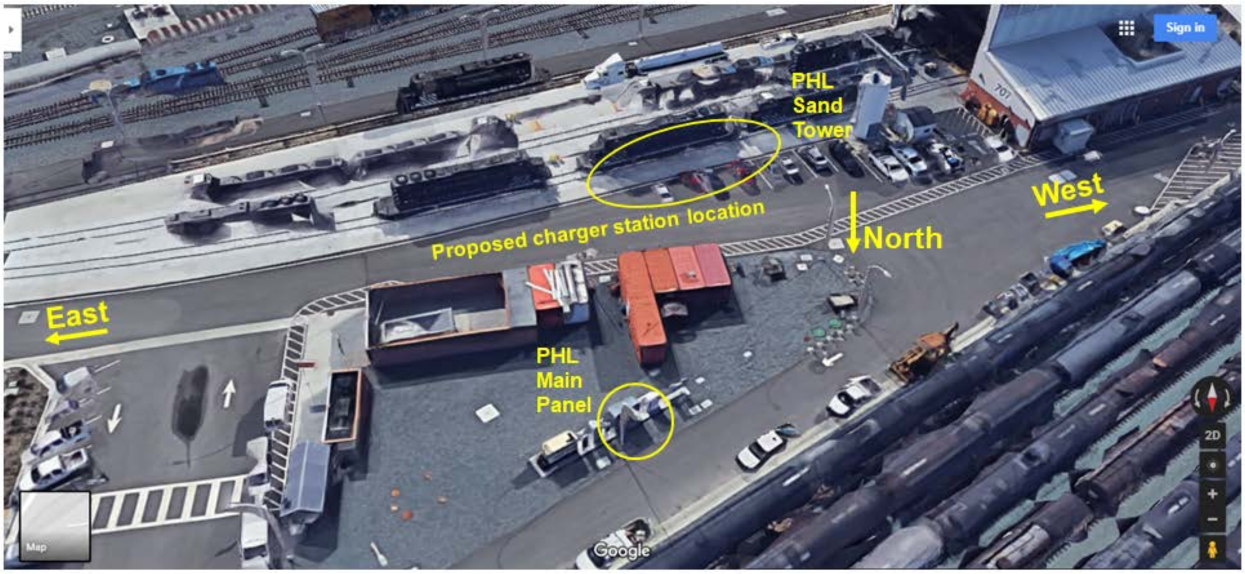
- Task 1.0 Administration and Project Management
- Task 2.0 Design and Construction of Charging Infrastructure
- Task 3.0 Demonstration Locomotive Design and Build
- Task 4.0 Demonstration
- Task 5.0 Data Collection, PEMS and Analysis

Task 1.0 Administration and Project Management will be carried out by the Harbor Department including all grantee administration duties. If awarded, a Kick-off meeting will be held as soon as possible to discuss the work plan, task performance details, schedule, and the approach for issue/problem resolution.

Task 2.0 Design and Construction of Charging Infrastructure will also be carried out by the Harbor Department, with technical support from LADWP. While charging infrastructure for the VeRail VR21C-z locomotive will have to be installed, it is being funded by the Harbor Department and designed in partnership with LADWP to ensure there are no adverse grid impacts. As it is an electric technology, no mobile fueling is needed for this technology. Renewable energy will be used to the extent it is supplied from LADWP as part of its base electricity mix. Currently, 25 percent of all energy retail sales at LADWP are from renewable energy.

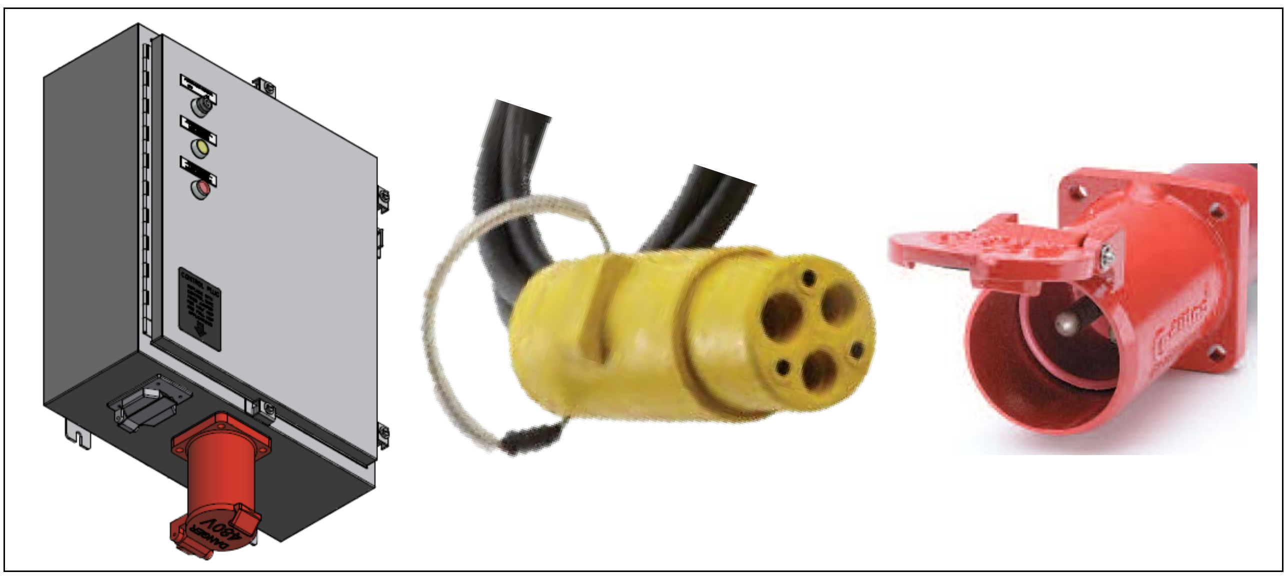
The size of the charging system was determined by evaluating normal operating conditions at PHL. The VeRail VR21C-z locomotive battery system is capable of supporting a continuous current output of 3,150 Amps. This is an average of 225 Amps per battery pod. However, for 90% of the switcher duty cycle the battery pods never pull more than 90 Amps at nominal voltage. So, while the batteries are rated for much higher currents, normal operating conditions require much lower current draws. Therefore, for the purposes of recharging, it has been determined that a 200 Amp service is sufficient to supply a reasonable recharge cycle for the locomotive demonstration. This will provide approximately 14-15 amps of power to each battery pod during recharge, which will allow the entire battery system to be recharged in about 12 hours. A 200 Amp service not only supports a reasonable recharge time for the locomotive, but by going with a 200 Amp service for recharging, the existing power service to PHL can be utilized without a need for upgrading the main service feed to PHL's facility. Based on the location of the LADWP main service to PHL's facility, increasing the service to the entire PHL facility would be extremely costly, requiring new underground service cables to be run under almost a dozen existing yard tracks. PHL's main service panel would also need to be upgraded. So, use of the 200 Amp service currently available from the PHL main panel is the most cost effective means of supporting this demonstration.

The electric service provided to the locomotive will be standard 480VAC 3-phase electric taken directly from the existing main power panel at PHL. The PHL main panel is located only about 100 feet from the locomotive service track where the recharging will take place. POLA will install three poles from the PHL main panel to the locomotive service area charger. Poles will be located at the PHL main panel, next to the service track, and there will be one intermediate pole between the two "endpoint" poles.



Location of PHL locomotive facility and main power panel

The charger itself will be mounted on the pole located at the locomotive service area. This will put the charger within about 10 feet of the locomotive service track. The project will use a standard 480VAC, 200 Amp service connection box commonly used for connecting ground service to passenger cars and locomotives. The connection from the electric charging station to the locomotive is made through a single standard FRA approved three-phase HEP electric cable rated at 600VAC 400 Amps (more than double what is needed for the proposed charging infrastructure).



Proposed pole mounted 480VAC 200 Amp Recharge box, standard HEP cable, and locomotive power receptor

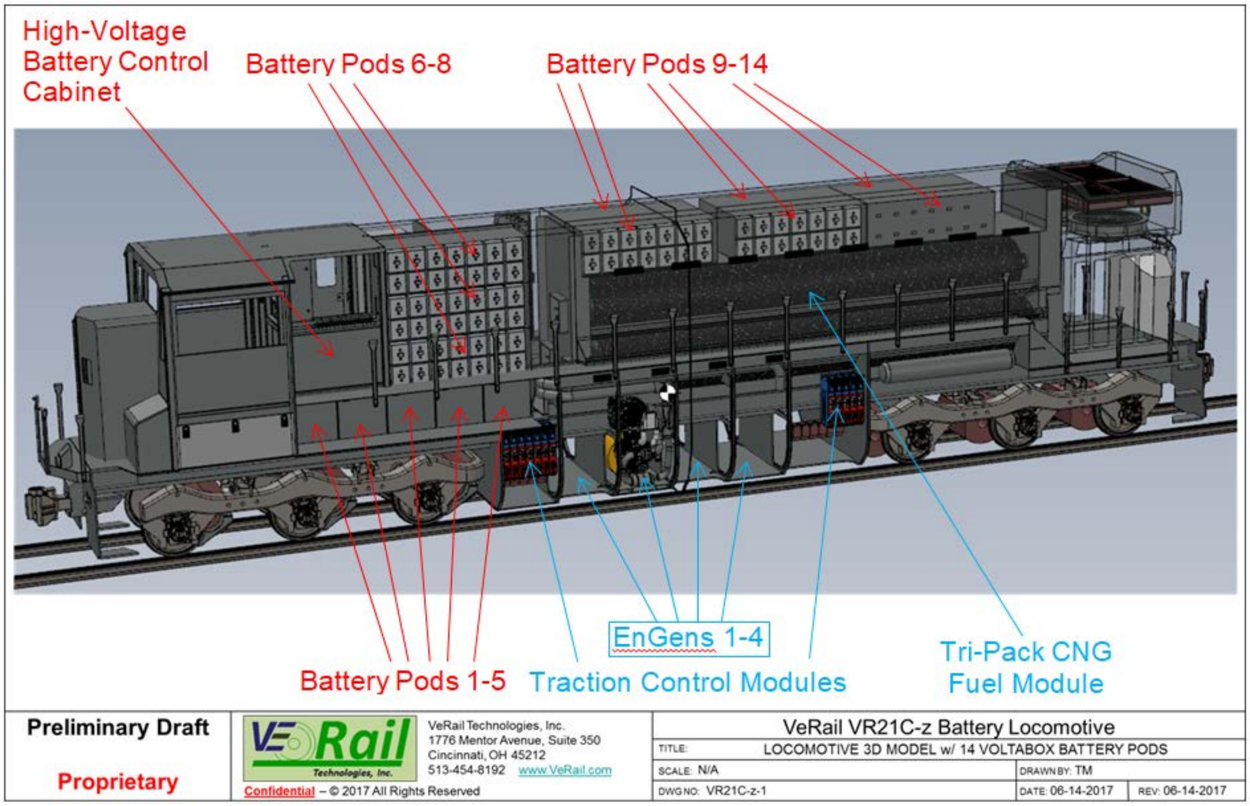
The proposed charging station (see in illustration above) includes an interlock that does not allow the power cable to be energized unless it is plugged into the locomotive. Thus, personnel are kept safe from high voltage during charging cable hookup. The charging station also contains a "smart meter" that logs meter readings during the charge process. This data will then be available for analysis by the data collection and reporting group. The "smart meter" chosen is the same meter used for Norfolk Southern battery locomotive NS 999 which is mentioned in the 2016 ARB Freight Locomotive technology assessment. The proposed charging infrastructure will not be available for non-project fleets.

Task 3.0 Demonstration Locomotive Design and Build will be completed by VeRail and its technical team of Voltabox, ATS and TMV. VeRail will complete the design and integrate zero-emission track-miles capability into the demonstration locomotive, including ordering all the components. The zero-emission track-miles capabilities will be added to VeRail's existing VR21C4-nz locomotive. The proposed zero-emission battery system will be capable of supporting the full 2,100 horsepower power requirements of the locomotive so that zero-emission battery operation of the locomotive will be equal to the power output of the near-zero emissions VR21C4-nz natural gas locomotive.

The proposed battery system to be added to the existing VR21C4-nz locomotive will be comprised of 14 battery "pods". Each battery pod is rated at 577VDC nominal. This voltage is high enough to supply the voltage needed for the locomotive to operate within its required speed range, which on the PHL never exceeds 10-15 MPH in the port area, and 35-40 MPH on the Alameda Corridor. Most ports operations never exceed 10 MPH. Since batteries produce a higher voltage when fully charged and a lower voltage when approaching their maximum 80% DoD, the actual voltage range of the battery system will be between 525VDC and 677VDC. Even at the lower 525VDC range this is sufficient to provide enough speed for the locomotive to operate in all venues.

The battery packs themselves are rated for 225 Amps continuous power draw (also called the current draw). Since there are 14 battery pods, and these pods will be connected in series, the total amperage available to the locomotive is 3,150 continuous Amps of power. This is high enough to match the continuous amperage output of current diesel-electric locomotive traction alternators and will thus meet the tractive effort requirements of the current PHL locomotives.

The battery system will integrate with the existing VR21C4-nz traction control modules from American Traction Systems (ATS). The high-voltage traction control modules are located under the frame of the VR21C4-nz locomotive, in close proximity to the four natural gas EnGens. The high voltage control equipment for the batteries will be located in a high-voltage battery compartment behind the new VeRail crashworthy road-switcher cab. The high-voltage battery cabinet is thus in close proximity to the forward battery pods 1-8. The high voltage battery control modules are of the same design and from the same manufacturer (ATS) as the traction control modules. They thus will utilize the same cooling package as the existing traction system modules and will also be familiar in design and mounting to locomotive maintenance personnel.



Task 4.0 Demonstration will be carried out by PHL with support from VeRail and the technical team of Voltabox, ATS and TMV. During the demonstration, PHL will operate the project locomotive in regular revenue service for a period of nine months. The locomotive will be fully instrumented to track a comprehensive data set. This data collection will provide detailed information on the zero-emission track miles operated each shift. As noted earlier, the locomotive has CNG operational capability, which will only be used during shifts that exceed the zero-emission track-miles capability of the demonstration locomotive. The data collection system will capture these cases and will be able to document the conditions under which the full shift operation could not be covered by the battery system. Once the demonstration is complete, the locomotive itself can be purchased by PHL at a discount; the batteries and charging equipment, which would be funded under this proposed grant project, would be available at no cost to PHL. As stated in Attachment 5, this demonstration will operate throughout a number of disadvantaged communities.

For Task 5.0 Data Collection, PEMS and Analysis, the Harbor Department is using its technical support subcontractor team, Tetra Tech and CE-CERT, for third-party data collection during the demonstration period to ensure the data will be reported as required by CARB in accordance with Appendix F – Data Collection Requirements. Additionally, Tetra Tech and CE-CERT are currently available to perform this work through a current "on-call" contract with the City of Los Angeles, Harbor Department.

A detailed breakdown of tasks, showing responsible parties for each task and subtasks, is provided below. A project schedule, which shows the timing of tasks that lead to the on-time completion of the demonstration project, is presented in the table following the work plan details.

Task 1.0 Administration and Project Management –Harbor Department
(1Q 2018-March 30, 2020)

Task 1.1 Kick-off Meeting – Zero-Emission Track-Miles Locomotive Demonstration Project Team
The project team will meet with CARB and third-party data analysis team (TetraTech/CE-CERT) to discuss the work plan, task performance details, schedule, and the approach for issue/problem resolution.

Task 1.2 Monthly Project Update Meetings and Reports – Harbor Department
The Harbor Department will coordinate monthly project update meetings that will be held via WebEx or teleconference to discuss progress. The meetings will follow a defined agenda that will cover project status update, difficulties encountered, upcoming deliverables, pending disbursement requests, and schedule of the next update meeting.

Task 1.3 Final Report – Harbor Department
At the completion of the project, the Harbor Department will submit a final report to ARB that describes the project goals and objectives, methods, results of the demonstration, future application of the technologies, and commercialization prospects.

Task 1.0 Deliverables: Monthly Agenda, Monthly Project Status Reports, Disbursement Requests, and draft Final Report on Feb 14, 2020.

Task 2.0 Design and Construction of Charging Infrastructure – Harbor Department
(Jan 2018-Dec 2018)

Task 2.1 Permitting and Administration for Task 2.0
The Harbor Department will acquire any permits necessary for infrastructure construction at the PHL Facility. Also, as-needed administrative services for any tasks in Task 2.0, including charging infrastructure testing and commissioning and producing associated reports.

Task 2.2 Charging Station Installation and Power Supply Connection (1Q 2018-2Q 2018)
The Harbor Department will design and build the charging infrastructure at the PHL Facility. A preliminary assessment of the existing electric infrastructure determined that the substation on the terminal has a dedicated transformer that is more than sufficient for the demonstration project's proposed load. The Harbor Department will manage the installation and associated system integration. POLA engineering estimates approximately three months for installation once design is complete. The required charging equipment will be sourced from Northwest Rail Electric and will connect to standardized electrical infrastructure. The charging system consists of a base charger cabinet, support equipment, and cable to connect to the on-board charger unit.

Task 2.3 Testing and Commissioning (Final Commissioning when Locomotive is deployed)
The Harbor Department will provide the desired sequences of operation for the electrical monitoring and controls system. Once all of the equipment is fully operational, the Harbor Department will lead the commissioning effort of the overall system being installed under this project. This will include technical advice from LADWP including operation for peak shaving and islanded operation. The commissioning procedures and results will be documented in a final commissioning report to be included in the reports to be submitted to ARB.

Task 2.0 Deliverables: As-Built Drawings and Testing and Commissioning Report

Task 3.0 Demonstration Locomotive Design and Build – VeRail
(1Q 2018 – 1Q 2019)

Task 3.1 Locomotive Design and Build, Purchase Parts – VeRail, Voltabox, American Traction Systems (ATS), TMV Control Systems (TMV), (Jan 2018 – Oct 2018)

VeRail will complete design and integrate zero-emission track-miles capability into the demonstration locomotive, including ordering all the components listed below. VeRail will test all drive system components on the locomotive and then test the entire system to ensure it functions properly. They will then undertake a series of drive tests to validate the basic functionality and safety of the system.

Task 3.1a – Charge Input Rectifier (sourced from ATS)
Task 3.1b – Battery Pod Design and Testing (sourced from Voltabox)
Task 3.1c – Battery Pods – 13 Purchased, One Donated (sourced from Voltabox)
Task 3.1d – High Voltage Control System Development (sourced from ATS)
Task 3.1e – Locomotive Control System Computer Upgrades (sourced from TMV)
Task 3.1f – Cooling Systems
Task 3.1g – Battery Mounting Engineering/Testing

Task 3.2 Demonstration Locomotive Deployment – VeRail and PHL (4Q 2018 – 1Q 2019)

Upon delivery and deployment of the locomotive at the PHL facility, charging infrastructure will be tested, and training of PHL operational and maintenance crews will begin. VeRail will provide on-site and classroom training up to 40 hours for all personnel involved with operation of the locomotive, as well as a printed and digital set of operator training manuals.

Task 3.0 Deliverables: Updated Design Package (3.1), Invoices for purchases (3.1), Photographs of assembled subsystems (3.1), and Commissioning Report (3.2).

Task 4.0 Demonstration – PHL, VeRail
(1Q 2019 – 3Q 2019)

The demonstration phase will show how zero-emission locomotive can operate conducting daily PHL switching duties. Following successful commissioning and deployment of equipment and training of staff on operation and maintenance, a nine-month demonstration will begin. It is anticipated that equipment will be capable of operating continuously for an 8-hour shift.

Task 4.0 Deliverables: Status reports on equipment in-servicing and operation

Task 5.0 Data Collection and Analysis –Third Party Data Contractor Tetra Tech
(1Q 2019 – 4Q 2019)

During demonstration, data will be collected from baseline and battery locomotives and equipment for hours of use, energy usage, vehicle performance variables, type of operation/application, vehicle/equipment maintenance, as well as general feedback on operator acceptance.

Task 5.1 Field Data Collection

Locomotives will be equipped with an event recorder which also tracks GPS data. This device is provided by PHL and VeRail, who will ensure that the data is available. The event recorder, including GPS, provides the ability to monitor all performance parameters in real-time from a cloud-based server, including fuel efficiency (miles/kWh), battery state-of-charge (SOC), mileage/odometer readings, runtime, idle time, kWh of operation (including detailed amperage and voltage data), battery temperature, speed, and charging current/voltage. All real-time and historical data will be available in chart form and as a download for analysis by the Harbor Department, ARB, and the third party data analysis firm (Tetra Tech/CE-CERT).

Task 5.2 Portable Emissions Measurement Systems (PEMS) Testing

CE-CERT will provide one to two weeks of PEMS testing, including travel to the site, installation and equipment preparation on-site, and actual testing. PEMS testing will incorporate typical pollutants, including THC, CO, NOx, PM, and CO2. Since CH4 is not typically incorporated into PEMS system, CH4 emissions will be determined as a percentage of the THC emissions measurements. This can be done based on factors provided in the Code of Federal Regulations (CFR) for determine methane emissions when a dual FID is not available, or based on typical percentages of CH4 found in diesel or other exhaust. A PEMS for the measurement of PM can also be included in the testing. It is expected that the natural gas and diesel locomotives will take one week each to test, so depend on whether one or both locomotives will need to be tested, this campaign will last one to two weeks. Note that the number of hours/days on each piece of equipment will depend on the number of hours of testing required during each test day, and the level of assistance that is available on-site for the installation of the equipment.

Task 5.3 Data Analysis

It is expected that all data collection for the analysis will be provided electronically via a remote data link by PHL and VeRail. For the potential development of a hybrid Ultra-low NOx natural gas and battery electric switcher locomotive, Tetra Tech team will process and analyze the collected data to determine activity patterns including hours of operation, days of operation per year, miles traveled per day using GPS data (and associated odometer reading per day and per shift if shift times are provided), average value and distribution of speed and acceleration based on GPS data, and idling time. GPS data can be analyzed to determine the number of trips between specific locations that are related to loading and unloading cargo, and refueling. This information will be used to assess the performance and duty cycle of the different equipment between the advanced technology equipment and the baseline equipment as a function of time, including the number of trips, and typical loading times, These parameters can be evaluated for a 3-9 month demonstration period, for a normal vs. peak period (i.e., holiday, overtime, double shift), and for specific periods of interest (e.g., high and low temperature operation, during the first and last hour of each shift, etc.).

Tetra Tech/CE-CERT will analyze the performance of the locomotive in terms of the state-of-charge (SOC) throughout the work shift (minute-by-minute), fuel/energy consumption rate per work completed/distance driven, and fuel/energy consumption while idling. It is assumed for this proposal that the SOC, energy consumption, and other battery performance parameters can be obtained directly from the locomotive control computer as part of the normal data logging connection. It is anticipated that perhaps two weeks of engineering time will be needed to develop the appropriate configuration files to gather this information for the different vehicles, and this is incorporated in the budget. Hybrid electric usage will be reported using the metrics of miles per kWh and hours per kWh. Battery degradation in terms of battery charge/power output and the SOC that can be obtained on a full charge will also be determined over the length of the project.

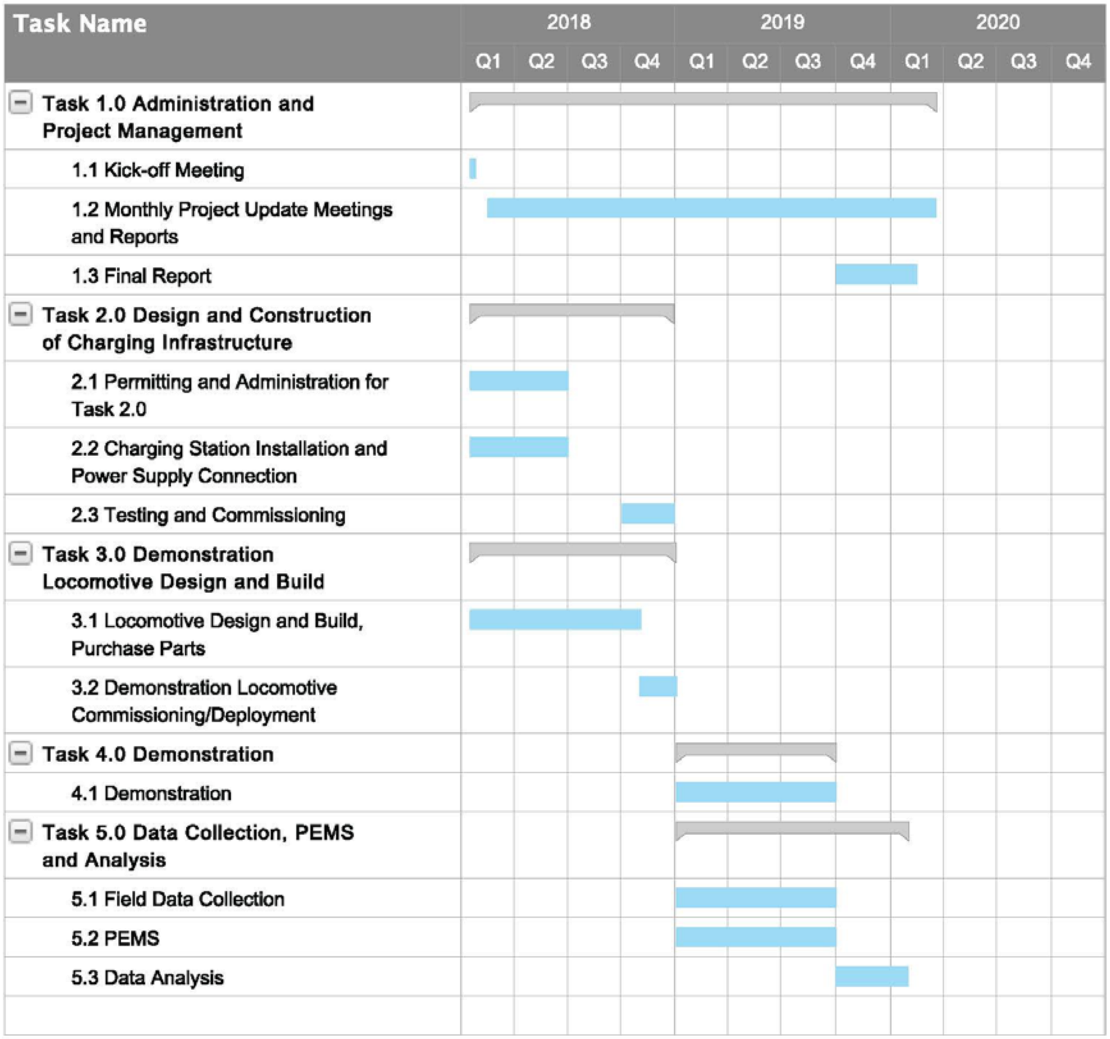
Task 5.0 Deliverables: Electronic data in the format required by ARB, Data Analysis Report

The Grantee plans on pursuing official verification at the end of this demonstration. All documentation in support of that verification or certification will be provided to CARB's Project Liaison.

Project Schedule

Task	Description	Start Date	Completion Date
1	**Administration & Project Management**	**Est. 1Q 2018**	**30-Mar-20**
1.1	Kick Off Meeting	Est. Jan 2018	Est. Jan 2018
1.2	Monthly Project Update Meetings & Reports	Est. Jan 2018	30-Mar-20
1.3	Final Report	4Q 2019	Draft Feb 14, 2020
2	**Design and Construction of Charging Infrastructure**	**Est. Jan 2018**	**4Q 2018**
2.1	Permitting and Administration for Task 2.0	Est. Jan 2018	Est. Jun 2018
2.2	Charging Station Installation and Power Supply Connection	Est. Jan 2018	Est. Jun 2018
2.3	Testing and Commissioning	4Q 2018	4Q 2018
3	**Demonstration Locomotive Design and Build**	**1Q 2018**	**1Q 2019**
3.1	Locomotive Design and Build, Purchase Parts	1Q 2018	Oct 2018
3.2	Demonstration Locomotive Commissioning/Deployment	4Q 2018	1Q 2019
4	**Demonstration**	**1Q 2019**	**3Q 2019**
4.1	Demonstration	1Q 2019	3Q 2019
5	**Data Collection and Analysis**	**1Q 2019**	**4Q 2019**
5.1	Field Data Collection	1Q 2019	3Q 2019
5.2	Portable Emissions Measurement Systems (PEMS) Testing	1Q 2019	3Q 2019
5.3	Data Analysis	3Q 2019	4Q 2019

Zero-Emission Track Miles Demonstration Project Schedule (Gantt)



ATTACHMENT 3: EMISSION REDUCTION AND COST-EFFECTIVENESS CALCULATIONS

Below is a detailed GHG and criteria pollutant emission reduction and cost-effectiveness evaluation for the POLA Zero-Emission Track-Miles Locomotive Demonstration Project, based on ARB's Appendix D Guidance document entitled: "Methodology for Determining Emission Reductions and Cost-Effectiveness." Baseline equipment specifications are based on PHL's real-world operation, layered with ARB's required use of Tier 4 baseline engine certification. Actual benefits will be evaluated as part of the in-service demonstration, an important effort since PHL experiences some of the most extreme duty cycle operations in the industry. Since the primary objective of this project is to demonstrate zero-emissions track-mile operation over the entirety of PHL's harshest shifts (8.5 to 12 hours/shift), the project team projects 100% of the baseline emissions will be offset by the proposed advanced technology (i.e., this is our design goal).

Description of Baseline Locomotive:

- Off-Road diesel engine with electric drivetrain: Tier-4 certification, 2,100 hp
- Diesel gallons per operating hour: 13.9 gallons per hour
- Operation: 3,125 hours per year; 43,438 gallons per year
- Locomotive cost at demonstration: $2,800,000
- Locomotive cost two years after demonstration: $3,000,000

Description of Advanced Technology Locomotive:

- Battery-electric locomotive charged via grid power
- Energy requirements during demonstration operation: 100% on electricity
- Locomotive cost at demonstration: $4,300,000
- Locomotive cost two years after demonstration: $4,000,000

Variables Used in Calculation:

Carbon Intensity (CI)

From Appendix D - Table II-2: Fuel Carbon Intensity Values

$CI_{diesel} = \frac{102.01\ gCO2e}{MJ}$ for table pathway identifier ULSD001

$CI_{electricity} = \frac{105.16\ gCO2e}{MJ}$ for table pathway identifier ELC001

Energy Density (ED)

Appendix D - Table II-2:-1: Fuel Energy Density

$ED_{diesel} = \frac{134.47MJ}{gal\ diesel}$

$ED_{electricity} = \frac{3.60\ MJ}{kWh}$

Energy Efficiency Ratio (EER)

Appendix D - Table II-3: EER Values for Fuels Used in LD, MD and HD Applications

$EER_{electric\ heavy\ rail} = 4.6$

Step 1: Convert diesel used per year to the amount of electricity to do the same work using Formula 3 and the above variables:

$$Replacement\ Fuel\ Usage\ \left(\frac{kWh}{yr}\right) = \left(\frac{43{,}438\ gal\ diesel}{year}\right) * \left(\frac{134.47\ MJ}{1\ gal\ diesel}\right) * \left(\frac{1\ kWh}{3.6\ MJ}\right) * \left(\frac{1}{4.6}\right)$$
$$= 352{,}724\ \left(\frac{kWh}{yr}\right)$$

Step 2: Determine the GHG emissions that are attributed to the baseline diesel-fueled locomotive, using Formula 1 and the above variables:

$$GHG\ EF_{base} = \frac{102.01\ g\ CO_2e}{MJ} * \frac{134.47\ MJ}{gal\ diesel} * \frac{43{,}438\ gal}{year} * \frac{1\ metric\ ton\ CO_2e}{1{,}000{,}000\ grams} = \mathbf{595.85}\ \frac{\textbf{metric tons CO}_\mathbf{2}\textbf{e}}{\textbf{year}}$$

Step 3: Determine the GHG emissions that are attributed to the advanced technology locomotive:

$$GHG\ EF_{base} = \frac{105.16\ g\ CO_2e}{MJ} * \frac{3.60\ MJ}{kWh} * \frac{352{,}720\ kWh}{year} * \frac{1\ metric\ ton\ CO_2e}{1{,}000{,}000\ grams} = \mathbf{133.53}\ \frac{\textbf{metric tons CO}_\mathbf{2}\textbf{e}}{\textbf{year}}$$

Step 4: Determine the GHG emissions reductions that are associated with the proposed project using Formula 4, populated by results from Step 2 and Step 3 above:

$$Project\ GHG\ ER_{annual} = GHG\ EF_{base} - GHG\ EF_{adv\ tech} = \frac{595.85\ metric\ tons\ CO_2e}{year} - \frac{133.53\ metric\ tons\ CO_2e}{year} = \frac{\mathbf{462.32\ metric\ tons\ CO_2e}}{\mathbf{year}}$$

Step 5: Determine the annual criteria and toxic air pollutant emission reductions that are associated with the proposed project. The locomotive will be used 100% of the time in California. There are no criteria pollutant emissions associated with the use of the battery-electric locomotive. Select Tier 4 criteria pollutant emission factors from Table IV-12b and the fuel consumption rate factor from Table IV-19 and apply them to Formula 13:

$$NO_x = 1.22\frac{g\ NO_x}{bhp-hr};\ ROG = 0.15\frac{g\ ROG}{bhp-hr};\ PM_{10} = 0.026\frac{g\ PM_{10}}{bhp-hr}$$

$$\mathbf{Locomotive\ Annual\ ER_{NO_x}} = \frac{1.22\ g\ NO_x}{bhp-hr} * \frac{15.2\ bhp-hr}{gal\ diesel} * \frac{43{,}438\ gal\ diesel}{year} * 100\% * \frac{1\ ton}{907200\ g} = \frac{\mathbf{0.888\ ton\ NO_x}}{\mathbf{year}}$$

$$\mathbf{Locomotive\ Annual\ ER_{ROG}} = \frac{0.15\ g\ ROG}{bhp-hr} * \frac{15.2\ bhp-hr}{gal\ diesel} * \frac{43{,}438\ gal\ diesel}{year} * 100\% * \frac{1\ ton}{907200\ g} = \frac{\mathbf{0.109\ ton\ ROG}}{\mathbf{year}}$$

$$\mathbf{Locomotive\ Annual\ ER_{PM_{10}}} = \frac{0.026\ g\ PM_{10}}{bhp-hr} * \frac{15.2\ bhp-hr}{gal\ diesel} * \frac{43{,}438\ gal\ diesel}{year} * 100\% * \frac{1\ ton}{907200\ g} = \frac{\mathbf{0.019\ ton\ PM_{10}}}{\mathbf{year}}$$

Step 6: Determine the weighted annual surplus emission reductions (WER) that are associated with the proposed project using the results from Step 5 above and Formula 11:

$$Locomotive\ WER = Annual\ ER_{NO_x} + Annual\ ER_{ROG} + 20 * \left(Annual\ ER_{PM_{10}}\right) = \frac{0.888\ ton\ NO_x}{year} + \frac{0.109\ ton\ ROG}{year} + 20 * \frac{0.019 ton\ PM_{10}}{year} = \frac{\mathbf{1.377\ ton}}{\mathbf{year}}$$

Step 7: Determine the incremental cost of the proposed technology using Formula 10 and the baseline and advanced technology equipment costs. Cost effectiveness is calculated for two scenarios: (1) two year project term based on costs at the time of demonstration, and (2) ten year project term, with costs projected two years after the completion of the demonstration project.

$$Incremental\ Cost\ = Cost\ of\ New\ Tech - Cost\ of\ Baseline\ Tech$$
$$Incremental\ Cost_{2\ years} = \$4{,}300{,}000 - \$2{,}800{,}000 = \$\mathbf{1,500,000}$$
$$Incremental\ Cost_{10\ years} = \$4{,}000{,}000 - \$3{,}000{,}000 = \$\mathbf{1,000,000}$$

Step 8: Determine the GHG emission reduction cost effectiveness (CE) for the proposed project using Formula 5 and results from Step 4 and Step 7, where CRF = Capitol Recovery Factor:

$$GHG\ CE = \frac{CRF * Incremental\ Cost}{GHG\ ER_{annual}}$$

$CRF_2 = 0.515$ and $CRF_{10} = 0.111$ per Moyer Table G-3a (2-year and 10-year lives, respectively)

$$GHG\ CE_2 = \frac{\frac{0.515 * \$1{,}500{,}000}{year}}{\frac{462.32\ metric\ tons\ CO_2e}{year}} = \frac{\$\mathbf{1,671}}{\boldsymbol{metric\ ton\ CO_2e}}$$

$$GHG\ CE_{10} = \frac{\frac{0.111 * \$1{,}000{,}000}{year}}{\frac{462.32\ metric\ tons\ CO_2e}{year}} = \frac{\$\mathbf{240}}{\boldsymbol{metric\ ton\ CO_2e}}$$

Step 9: Determine the criteria pollutant cost effectiveness for the proposed technology using Formula 8 and the results from Steps 6 and 7:

$$Cost - effectiveness\ (\frac{\$}{ton}) = \frac{CRF * Incremental\ Cost}{WER}$$

$$WER\ Cost - effectiveness\ (@\ 2\ year\ term) = \frac{\frac{0.515 * \$1{,}500{,}000}{year}}{\frac{1.377\ ton}{year}} = \frac{\$\mathbf{561,002}}{\boldsymbol{weighted\ tons}}$$

$$WER\ Cost - effectiveness\ (@\ 10\ year\ term) = \frac{\frac{0.111 * \$1{,}000{,}000}{year}}{\frac{1.377\ ton}{year}} = \frac{\$\mathbf{80,610}}{\boldsymbol{weighted\ tons}}$$

ATTACHMENT 4: PROPOSED BUDGET, PROJECT MILESTONE, AND DISBURSEMENT SCHEDULE

Proposed Budget

The proposed budget includes all estimated labor and equipment/material costs associated with the POLA Zero-Emission Track-Miles Locomotive Demonstration project. The proposed project budget is $3,858,037 consisting of $2,793,717 in proposed ARB grant funds from this solicitation, and $1,064,320 in matching funds, both cash and in-kind from the proposed project team. The table below presents details on the project funding sources, including cash, in-kind services, and grant funds. The project partners will contribute 27.6% of the total project cost in matching funds, of which 23.1% is cash match. A draft disbursement schedule is presented the table directly following.

Proposed Budget					
TASK 1.0 – Project Administration					
Direct Labor plus Expenses		**Grant**	**Match Funding**		
Position/Classification	Hourly rate	CARB	Cash	In-Kind	Total
NOTE: POLA staff time is being contributed as needed to successfully implement this project, but not as an official match.		$0	$0	$0	$0
Task 1.0 Subtotal		*$0*	*$0*	*$0*	*$0*
TASK 2.0 – Design and Construction of Charging Infrastructure					
Project Costs	**N/A**				
Task 2.1-Permitting and Administration for Task 2.0		$0	$21,246	$0	$21,246
Task 2.2-Charging Station Installation and Power Supply Connection		$0	$112,075	$0	$112,075
Task 2.0 subtotal		*$0*	*$133,321*	*$0*	*$133,321*
TASK 3.0 – Demonstration Locomotive Design and Build					
Project Costs	**N/A**				
Task 3.1-Locomotive Battery Equipment and Controls		$0	$0		$0
3.1a Charge Input Rectifier		$0	$0	$12,000	$12,000
3.1b Battery Pod Design and Testing		$105,000	$75,000	$0	$180,000
3.1c Battery Pods (13 Purchase, 1 Donation)		$2,079,337	$0	$159,949	$2,239,286
3.1d High-Voltage Control System Development		$263,380	$75,000	$0	$338,380
3.1e Locomotive Control Computer Upgrades		$56,000	$75,000	$0	$131,000
3.1f Cooling Systems		$40,000	$75,000	$0	$115,000
3.1g Battery Mounting Engineering/Testing		$250,000	$0	$0	$250,000
3.2 Demonstration Locomotive Commissioning/Deployment		$0	$60,000	$0	$60,000
Task 3.0 Subtotal		*$2,793,717*	*$360,000*	*$171,949*	*$3,325,666*
TASK 4.0 – Demonstration					
Project Costs	**N/A**				
Task 4.1-Demonstration		$0	$229,050		$229,050
Task 4.0 Subtotal		*$0*	*$229,050*	*$0*	*$229,050*
TASK 5.0 – Data Collection and Analysis					
Project Costs	**N/A**				
Task 5.1-5.3 Data Collection, PEMS and Analysis		$0	$170,000		$170,000
Task 5.0 Subtotal		*$0*	*$170,000*	*$0*	*$170,000*
Total All		*$2,793,717*	*$892,371*	*$171,949*	*$3,858,037*
			% of total		
Grant Request		$2,793,717	72.4%		
Administration (Covered by Project Budget)		$0	0.0%		
Cash Match		$892,371	23.1%		
In-Kind Match		$171,949	4.5%		
Total Project Budget		**$3,858,037**	**100.0%**		

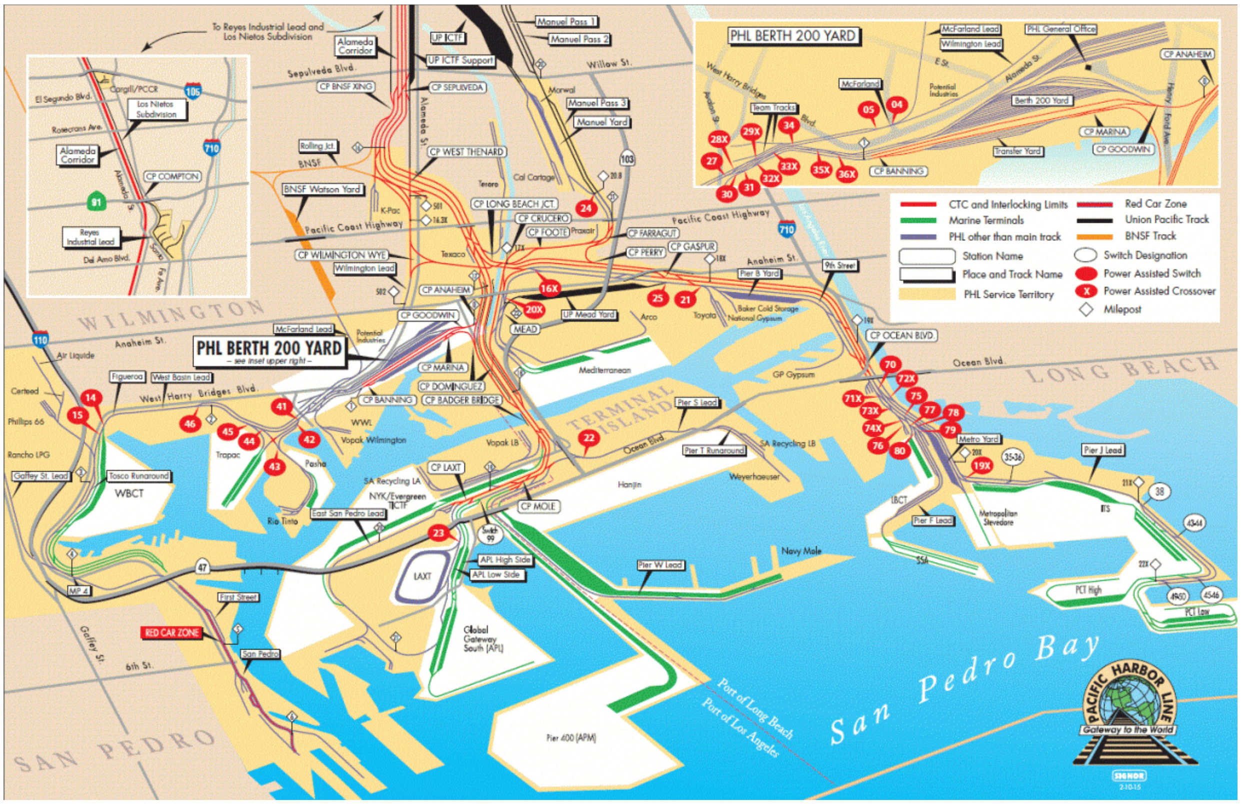
Project Milestone and Disbursement Schedule

Project Milestone and Disbursement Schedule					
Milestone	Task Description	ARB Grant Request Project Funding		Match Funding	
		Project Funds	Administrative Funds	Project Funds	Administrative Funds
Task 1.0 Administration and Project Management					
1.1	Kick-Off Meeting	$0	$0		
1.2	Monthly Project Update Meetings & Reports	$0	$0		
1.3	Final Report	$0	$0		
Task 2.0 Design and Construction of Charging Infrastructure					
2.1	Permitting and Administration for Task 2.0	$0	$0		$21,246
2.2	Charging Station Installation and Power Supply Connection	$0	$0	$112,075	
2.3	Testing and Commissionsing	$0	$0		
Task 3.0 Demonstration Locomotive Design and Build					
3.1	Locomotive Design and Build, Purchase Parts	$0	$0		
3.1a	Charge Input Rectifier	$0	$0	$12,000	
3.1b	Battery Pod Design and Testing	$105,000	$0	$75,000	
3.1c	Battery Pods (13 Purchase, 1 Donation)	$2,079,337	$0	$159,949	
3.1d	High-Voltage Control System Development	$263,380	$0	$75,000	
3.1e	Locomotive Control Computer Upgrades	$56,000	$0	$75,000	
3.1f	Cooling Systems	$40,000	$0	$75,000	
3.1g	Battery Mounting Engineering/Testing	$250,000	$0		
3.2	Demonstration Locomotive Commissioning/Deployment	$0	$0	$60,000	
Task 4.0 Demonstration					
4.1	Demonstration	$0	$0	$229,050	
Task 5.0 Data Collection and Analysis					
5.1-5.3	Data Collection, PEMS and Analysis	$0	$0	$170,000	
	Final Project Report (Completion of Task 1.3)	$0	$0		
Subtotal of Project Funds and Administrative Funds		*$2,793,717*	*$0*	*$1,043,074*	*$21,246*
Grant Total Funding Amount		**$2,793,717**		**$1,064,320**	
Total Project Amount		**$3,858,037**			
Disbursement will include the total dollar mount for that Milestone contingent upon completion of a specific task supported with a deliverable (as detailed in the Project Schedule.)					

Nearly 75% of the total grant request is budgeted directly to cover the cost of the batteries. This hardware and the associated control equipment is needed to build the zero emissions capabilities in the locomotive and will be purchased prior to deployment of the locomotive.

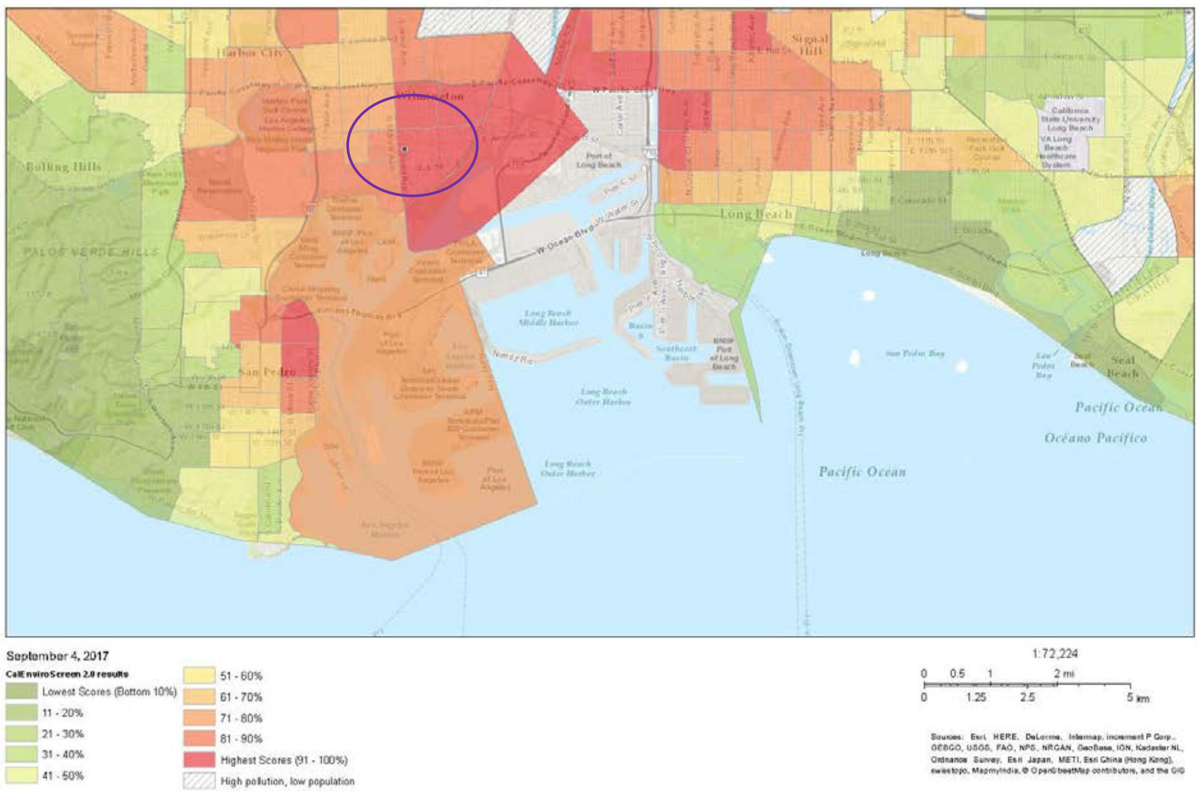
ATTACHMENT 5: DISADVANTAGED COMMUNITIES ELIGIBILITY DETERMINATION

The Zero-Emission Track-Miles Locomotive Demonstration Project will be conducted on PHL freight lines which are all located within several disadvantaged community census tracts. The charging station will be located at 705 North Henry Ford Avenue, Wilmington, CA 90744, a disadvantaged community. The track lines are all located within the "Freight Hub" of Los Angeles and Long Beach, which is in a zip code that contains a disadvantaged community census tract. The figure below illustrates where the PHL track lines are located. This encompasses areas of Wilmington, San Pedro and Long Beach.



This map below is from CalEnviroScreen 2.0 and it illustrates the disadvantaged communities designated by CalEPA for the purpose of SB 535 for the areas adjacent to where the PHL tracks are located and the zero-emission demonstration will take place. The purple circle is the location of PHL Headquarters. As can be seen from the image of the *PHL Operating Area and Surrounding Communities* below, with the exception of one area of Long Beach, many of the surrounding communities in proximity of the PHL operating area, the "Freight Hub" of Los Angeles and Long Beach, have a CalEnviroScreen 2.0 score in excess of 70%, and some in excess of 90%. Reducing emissions in these neighborhoods will have an incredibly positive effect on the disadvantaged communities that border PHL's operational area.

PHL Operating Area and Surrounding Communities



For this project, no buildings will be modified near any residences, daycare facilities, elder care facilities, medical facilities or schools. Equipment to be deployed will perform identical duties to diesel equipment already routinely utilized on PHLs tracks, though the project equipment is designed to complete these duties with without any negative air quality impacts to the terminal employees and local community. In addition to the reduction in criteria and GHG emissions from the project, neighboring communities will also benefit from noise reduction anticipated from the proposed demonstration locomotive.

Additional benefits include:

- Accelerating the reductions in GHG emissions in Wilmington and the surrounding communities of San Pedro and Long Beach
- Advancing innovative clean technologies
- Maximizing public and private resources to expedite clean energy solutions and meet air quality goals
- An economic benefit will be realized during construction of charging infrastructure and during demonstration and testing through an increased use of local business due to increased labor for installation, technical advisory services and data collection.

The Coalition for A Safe Environment (CFASE) will be part of the project team in a community advisor role, providing insights on how the project can provide economic, environmental, and community benefits to the surrounding disadvantaged communities. In addition to the Community Advisor, the Harbor Department has a dedicated community outreach program and holds a monthly meeting with the Neighborhood Council Presidents, which have representatives from the disadvantaged communities in the PHL operating area. This forum will serve as another platform to introduce the project to the surrounding community. An initial presentation about the project will be provided at the first opportunity, and updates will be provided over the course of the project, with a presentation on the project accomplishments at the end of the demonstration.

In addition to meetings with the Neighborhood Council Presidents, the Port of Los Angeles project team will also share results with the local community and other stakeholders by engaging in outreach activities that rely on press releases and social media. The Port's mailing list for its press releases includes 300 media outlets around the world. The Port uses Facebook, Twitter and YouTube to share information and these portals currently have more than 75,000 followers. Port staff has led and supported extensive stakeholder outreach and communication during similar prior and current projects. The Port will also share progress and results of the project with the community and has staff with communications expertise to ensure the project results are well-understood. Outreach via the aforementioned communication methods will be conducted at the following key milestones, at a minimum:

- Notice of Proposed Award
- Project Equipment Commissioning
- Demonstration completion, with summary of results

Project updates will also be provided to various national and international maritime association meetings as part of periodic technology briefings.

ATTACHMENT 6: PROCEDURES FOR HANDLING CONFIDENTIAL INFORMATION

The Port of Los Angeles Zero-Emission Track-Miles Locomotive Demonstration project application does not include any confidential information, and as such, the Confidentiality Provision is not included in this application.

ATTACHMENT 7: CALIFORNIA ENVIRONMENTAL QUALITY ACT WORKSHEET

Attachment 7: California Environmental Quality Act Worksheet

Please answer all questions in the worksheet below as completely as possible. It may also help you to think through the CEQA process necessary for your proposed project. CARB may request additional information in order to clarify responses provided on this worksheet.

1. **What are the physical aspects of the project? (Check all that apply and provide brief description of work, including any size or dimensions of the project).**

Project Aspect	Yes	No	Description of Project Aspect
Construction (including grading, paving, etc.)	☒	☐	Charging infrastructure
Trenching	☐	☒	
New or replaced pipelines	☐	☒	
Construction of underground facilities	☐	☒	
Modification or conversion of a facility	☐	☒	
New or modified operation of a facility or equipment	☐	☒	
On-road demonstration	☐	☒	
Paper study (including analyses on economics, feedstock availability, workforce availability, etc.)	☐	☒	
Laboratory research	☐	☒	
Temporary or mobile structures (skid-mounted)	☐	☒	
Design/Planning	☒	☐	Electrical hook-ups for charging infrastructure
Other (describe and add pages as necessary)	☒	☐	Battery-electric locomotive demonstration will be conducted within the Port of Los Angeles. Battery-electric technology will be demonstrated.

2. **Where is the project located or where will it be located? (Attach additional sheets as necessary.)**

Address	County	Type of Work to Be Completed at Site
Pacific Harbor Line, Inc. 705 North Henry Ford Ave. Wilmington, CA 90744	Los Angeles	In-service demonstration of battery electric locomotive will be conducted within the Port of Los Angeles with infrastructure located at the PHL facility.

3. **Will the project potentially have environmental impacts that trigger CEQA review? (Check a box and explain the answer for each question. Additionally, please provide a complete description of any direct physical changes and reasonably foreseeable indirect changes to the environment that may result from the project. Please provide as much detail as possible. You may provide additional information on supplemental pages as necessary.)**

Question	Yes	No	Don't Know	Explanation
Is the project site environmentally sensitive?	☐	☒	☐	
Is the project site on agricultural land?	☐	☒	☐	
Is the land on which the project would be built previously disturbed?	☒	☐	☐	
Is this project part of a larger project?	☐	☒	☐	
Is there public controversy about the proposed project or larger project?	☐	☒	☐	
Will historic resources or historic buildings be impacted by the project?	☐	☒	☐	
Is the project located on a site the Department of Toxic Substances Control and the Secretary of the Environmental Protection have identified as being affected by hazardous wastes or cleanup problems?	☐	☒	☐	
Will the project generate noise or odors in excess of permitted levels?	☐	☒	☐	
Will the project increase traffic at the site and by what amount?	☐	☒	☐	

Question	Yes	No	Don't Know	Explanation
Is the project expected to result in environmental impacts to any other resource area (e.g., air quality, aesthetics, water quality)? (Add pages as necessary.)	☐	☒	☐	

4. **Will the project require discretionary permits or determinations, as listed below?**

Type of Permit	No	Modified	New	Approving Agency	Reason for Permit, Summary of Process, and Anticipated Date of Issuance
Air Quality Permit	☒	☐	☐		
Water Quality Permit	☒	☐	☐		
Conditional Use Permit or Variance	☒	☐	☐		
Building Expansion Permit	☒	☐	☐		
Hazardous Waste Permit	☒	☐	☐		
Rezoning	☒	☐	☐		
Authority to Construct	☒	☐	☐		
Other Permits (List types)	☐	☐	☒	City of Los Angeles, California Coastal Commission*	All work on Port Property goes through the Application for Port Permit Process, which reviews the work-plan for all required permits. A preliminary review indicated that the only possible required permit would be a Coastal Development Permit, but the full determination will only happen upon grant award. Anticipated Date: 11/01/2017.

*Potentially required, will only be reviewed once the Port Permit Application is in.

5. **Of the agencies listed in #4, have you identified and contacted the public agency who will be the lead CEQA agency on the project?**

☒ **Yes**. Provide the name and contact information for the lead agency.

The City of Los Angeles will be the lead agency:

Contact: Christopher Cannon, Director of Environmental Management.

425 S. Palos Verdes St. San Pedro, CA, 90731; (310) 732-3763 ; CCannon@portla.org

☐ **No.** Explain why no contact has been made and/or a proposed process for making contact with the lead agency.

____
____
____

6. **If you identified an agency with discretionary approval authority over the project (see Item 4 above), has as the public agency prepared environmental documents (e.g., Notice of Exemption, Initial Study/Negative Declaration/Mitigated Negative Declaration, Environmental Impact Report, Notice of Determination) under CEQA for the proposed project?**

☐ **Yes**. Please complete the following and attach the CEQA document to this worksheet. (For "Not a project," the title of the document may be an e-mail, resolution, or letter.)

Type of Environmental Review	Title of Environmental Document (Attach the document to this form)	State Clearinghouse Number	Completion Date	Planned Completion Date (must be before approval of grant)
"Not a project" Email Letter Resolution Other:		N/A		N/A
Exempt (Resolution of public agency or Agenda Item approving Exemption)		N/A		N/A
Exempt (Notice of Exemption)		N/A		
Initial Study				
Negative Declaration				
Mitigated Negative Declaration				
Notice of Preparation				
Environmental Impact Report				
Master Environmental Impact Report				

Notice of Determination				
NEPA Document (Environmental Assessment, Finding of No Significant Impact, and/or Environmental Impact Statement)				

☒ **No**. Explain why no document has been prepared. Propose a process for obtaining lead agency approval and estimated date for that approval (must occur before ARB will approve the grant).

While the project is most likely to be determined an exemption (as an activity involving data collection, research and resource evaluation; article III, Class 6 of the Los Angeles City CEQA guidelines), our CEQA processing team cannot officially review and prepare the appropriate document without a formal Application for Port Permit (see section 4 above). Exemptions are typically processed in less than a week.

The proposed action is approval of agreements for testing and demonstration of one zero-emission battery operated locomotive to reduce emissions from goods movement activities. As an activity involving data collection, research and resource evaluation which does not result in a serious major disturbance to an environmental resource, the Director of Environmental Management has determined that the proposed action is exempt from the CEQA in accordance with article III, Class 6 of the Los Angeles City CEQA guidelines.

Certification: I certify to the best of my knowledge that the information contained in this worksheet is true and complete. I further certify that I am authorized to complete and sign this form on behalf of the proposing organization.

Name: Christopher Cannon

Title: Director of Environmental Management and Chief Sustainability Officer

Signature:

Phone Number: (310) 732-3763

Email: CCannon@portla.org

Date: September 4, 2017

ATTACHMENT 8: LETTERS OF COMMITMENT

The Harbor Department has included letters of commitment from our partners, subcontractors and technology demonstrators, as listed below to complete the application.

- Port of Los Angeles
- Pacific Harbor Line
- VeRail Technologies, Inc.
- Voltabox of Texas
- American Traction Systems
- TetraTech/CE-CERT
- South Coast Air Quality Management District
- Los Angeles Department of Water and Power
- Coalition For A Safe Environment

THE PORT OF LOS ANGELES 425 S. Palos Verdes Street Post Office Box 151 San Pedro, CA 90733-0151 TEL/TDD 310 SEA-PORT www.portoflosangeles.org

Eric Garcetti *Mayor, City of Los Angeles*
Board of Harbor Commissioners: Ambassador Vilma S. Martinez, *President*; David Arian, *Vice President*; Patricia Castellanos; Anthony Pirozzi, Jr.; Edward R. Renwick
Eugene D. Seroka *Executive Director*

September 6, 2017

Jack Kitowski, Chief
Mobile Source Control Division
California Air Resources Board
Mobile Source Control Division
9528 Telstar Avenue
El Monte, CA 91731

Dear Mr. Kitowski:

SUBJECT: OFF-ROAD ADVANCED TECHNOLOGY DEMONSTRATION PROJECTS APPLICATION

The City of Los Angeles Harbor Department (Harbor Department) is pleased to submit the attached application in response to the California Air Resource Board's Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program for Off-Road Advanced Technology Demonstration Projects. The Harbor Department's *Zero-Emissions Track-Miles Locomotive Demonstration Project* presented in this application will provide a comprehensive nine-month in-service demonstration of a zero-emissions-capable switcher locomotive handling rail cargo within the Ports of Los Angeles and Long Beach (Ports).

The Harbor Department is proposing to demonstrate a zero-emission track-mile switcher locomotive in the Ports, in partnership with VeRail Technologies, Pacific Harbor Line, the South Coast Air Quality Management District, the Los Angeles Department of Water and Power, and the Coalition for a Safe Environment. The project would demonstrate the VeRail VR21C-Z, a zero-emission battery-powered switcher locomotive design, capable of supporting the 2,100 horsepower requirements for full operational capability throughout the PHL network of in-harbor track lines. This demonstration will take place within the Ports and the adjacent disadvantaged communities of Wilmington, San Pedro, and Long Beach. With speeds of 10-15 miles per hour (mph) within the Ports and 35-40 mph on the Alameda Corridor, the PHL duty cycle for locomotives is the "Mount Everest" of switcher duty cycles, as typical switcher operations rarely exceed 10 mph. The 14-pod battery bank, rated at 1,820 kW-hours, will supply enough energy for a typical eight (8) hour working period without charging. Electric charging infrastructure will be installed to support the demonstration unit at the PHL facility in Wilmington, CA.

AN EQUAL EMPLOYMENT OPPORTUNITY - AFFIRMATIVE ACTION EMPLOYER
Printed on recycled paper

MR. KITOWASKI PAGE 2

The total project cost is $3,858,037 and the Harbor Department requests grant funding in the amount of $2,793,717 to co-fund the demonstration project. The project partners are providing 27 percent, or $1,064,320 in match funding ($892,371 cash and $171,949 in-kind), as indicated in the attached letters of support. The Harbor Department's project management team will provide all in-house support as an in-kind contribution to this important project.

Thank you for the opportunity to submit a proposal for this innovative project that will reduce dependence on foreign oil and emissions of greenhouse gas, smog, and toxic particulates. Please contact me at 310-732-3763 or via email at ccannon@portla.org, if you have any questions.

Sincerely,

CHRISTOPHER CANNON
Director of Environmental Management

CC:LW:TD:JG:mrx

Attachment

"FOR INFORMATION ONLY"

DATE: **SEPTEMBER 7, 2017**

TO: **BOARD OF HARBOR COMMISSIONERS**

SUBJECT: **CALIFORNIA AIR RESOURCES BOARD OFF-ROAD ADVANCED TECHONOLOGY DEMONSTRATION PROJECT GRANT APPLICATION**

On June 9, 2017, the California Air Resources Board (ARB) released a grant solicitation for Off-Road Advanced Technology Demonstration (Off-Road) Projects under the Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Programs for Funding Year 2016/2017. This grant solicitation is designed to fund $17 million worth of projects, statewide, that will accelerate the introduction of advanced emission reducing technologies on the cusp of commercialization into the California marketplace. This solicitation will consider projects that propose to develop off-road advanced technologies that have the potential to achieve greenhouse gas reductions. The project must be in or near disadvantaged communities to receive funding. There is also a 25 percent minimum match funding requirement, with a minimum of 10 percent of that match being in cash or labor. The remainder of the match may be fulfilled through in-kind services, equipment purchases, and electrical services during the term of the grant agreement. The grant application is due to ARB on September 7, 2017. Preliminary grantee award selection will be made around October 2017 with projects expected to begin by December 2017. All work under the projects must be completed by March 30, 2020.

The City of Los Angeles Harbor Department (Harbor Department) plans to apply for $2,793,717 under this grant solicitation for a Zero-Emission Track Miles Locomotive Demonstration Project (Project) with Pacific Harbor Line (PHL). The South Coast Air Quality Management District (AQMD) would also be a project partner. The proposed project will develop and demonstrate a zero-emission battery electric switcher locomotive, manufactured by VeRail Technologies Incorporated (VeRail), in normal rail operations throughout the Port of Los Angeles (POLA) and Port of Long Beach. The Harbor Department's proposal is an expansion of a recently approved project under the joint Ports Technology Advancement Program (TAP), which plans to develop and demonstrate a near-zero emissions switcher locomotive powered by natural gas. This proposed addition to the existing TAP project will add a bank of batteries to the same locomotive making it capable of operating in zero emissions mode for approximately eight (8) hours on a full charge. The locomotive when completed will be capable of being operated in either the natural gas powered near-zero emissions mode or the battery electric powered zero emissions mode.

If awarded the grant, the project partners (Harbor Department, PHL, VeRail, and AQMD) will satisfy the minimum 25 percent matching fund requirement through contributions for the following tasks:

Task 1) Installation of required electrical charging infrastructure;
Task 2) Data collection and analysis;
Task 3) Labor costs to develop, maintain, and demonstrate the equipment;

DATE: SEPTEMBER 7, 2017 **PAGE 2 OF 2**

SUBJECT: CALIFORNIA AIR RESOURCES BOARD OFF-ROAD ADVANCED TECHONOLOGY DEMONSTRATION PROJECT GRANT APPLICATION

Task 4) The cost for electricity to run the locomotive for the entirety of the project;
Task 5) Donated materials from the technology development team;
Task 6) Cash contribution from the AQMD; and
Task 7) Administrative costs from Harbor Department to manage the grant award.

The Table below summarizes the costs of this Project:

Project Partner	Cost Share Responsibility	Task Cost	Total Cost per Project Partner
Harbor Department	Task 1	$ 112,075	$ 303,300
	Task 2	$ 170,000	
	Task 7	$ 21,247	
VeRail	Task 3	$ 60,000	$ 241,949
	Task 5	$ 171,949	
PHL	Task 3	$ 210,195	$ 229,050
	Task 4	$ 18,855	
AQMD	Task 6	$ 300,000	$ 300,000
	Total Cost Share		**$ 1,064,320**
	Total Grant Request		**$ 2,793,717**
	Total Project Cost		**$ 3,858,037**

The Los Angeles Department of Water and Power has agreed to support this project as a technical advisor, and the Coalition for a Safe Environment, represented by Jesse Marquez, has volunteered to join the project team to provide support and advice as a community liaison.

The Harbor Department recognizes the importance of taking a leadership role in demonstrating zero and near-zero technologies in the San Pedro Bay port complex. This project will add to the legacy of industry-changing innovations developed here at the POLA, as one of the first zero emission capable freight switchers in the United States. The emission reductions associated with this project will benefit the communities surrounding the POLA.

If awarded, the Harbor Department will return to the Board of Harbor Commissioners for approval to enter into agreement(s) for the implementation of the approved project.

EUGENE D. SEROKA
Executive Director

MD:CC:LW:TD:JG:mrx
File: Y:_ADMIN_BOARD REPORTS\FOR INFO ONLY\2016 CARB GRANT\2017 CARB OFF-ROAD GRANT APPLICATION - FINAL - 9-6-17.docx

PACIFIC HARBOR LINE

September 6, 2017

Mr. Chris Cannon
Director of Environmental Management
Port of Los Angeles
425 S. Palos Verdes Street
San Pedro, CA 90733

Dear. Mr. Cannon:

Pacific Harbor Line (PHL) is pleased to continue its relationship with the Port of Los Angeles and VeRail by committing resources to demonstrate the VeRail VR21C-z electric locomotive as part of the Zero-Emission Track-Miles Demonstration project for the California Air Resources Board Off-Road Advanced Technology Demonstration Projects. This grant is very valuable to the continuing efforts PHL has with the Port of Los Angeles to make PHL the cleanest and most environmentally friendly port railroad operation in the world.

In June 2017, the mayors of Los Angeles and Long Beach signed a new pact setting zero emissions goals for POLA/POLB. This agreement particularly directs the nation's largest port complex to reduce air pollution by moving toward zero-emission trucks and yard equipment. Rail is apparently not exempt, which is why PHL is eager to demonstrate the VeRail VR21C-z battery locomotive.

In view of the move toward zero-emission vehicles, including zero-emission track-miles for locomotives, we are fully committed to being the demonstration partner for VeRail's planned zero-emission track-miles VR21C-z battery locomotive. It is very exciting for PHL to take the lead in emissions reduction and serve as a model for railroads across the U.S. and around the world. Therefore, we are pleased to offer our assistance and commitment to demonstrate the zero-emission locomotive in revenue service if awarded the California Air Resources Board (ARB) grant for Off-Road Advanced Technology Demonstrations. We understand that this demonstration will cost PHL approximately $230,000 to operate and maintain the locomotive for the duration of the project.

I would also like to point out that PHL operates a fleet of 23 low emission locomotives, the cleanest locomotive fleet in the United States. We intend to remain the nation's cleanest railroad and this commitment is in line with our support of the Ports and cities of Los Angeles and Long Beach to keep our port complex the cleanest in the world. As such, it is our goal to convert our entire locomotive fleet to near-zero and zero-emission track-miles and VeRail could play an integral part in this process. As soon as PHL determines that the VeRail locomotives are meeting their emissions goals and PHL's operational needs, we will submit funding applications to the State of California to upgrade our fleet. We would appreciate VeRail's support in this endeavor by providing whatever emissions, performance, and cost data and calculations we would need to apply for state and federal funds that should be available to us for this planned upgrade to near-zero and zero-emission track-miles VeRail locomotives.

Our Chief Mechanical Officer, James O'Kelley, and I look forward to continuing to work with you on this project and review the VeRail locomotive designs and manufacturing progress.

Sincerely,

Otis Cliatt II
President

Otis Cliatt II
705 N Henry Ford Ave • Wilmington, CA 90744
Telephone (310) 984-5765 • Fax (310) 834-1342

VeRail Technologies, Inc.

August 29, 2017

Mr. Christopher Cannon
Director of Environmental Management / Chief Sustainability Officer
Port of Los Angeles
425 S. Palos Verdes Street
Post Office Box 151
San Pedro, CA 90733-151

Chris:

This letter serves as our formal letter of commitment for the Port of Los Angeles (POLA) grant proposal to redesign a 2,100 horsepower 6-axle locomotive to incorporate zero-emission (i.e., battery power) capability and demonstrate this capability under the Zero-Emission Track-Miles Locomotive Demonstration Project. The POLA proposal is being submitted under the 2016-2017 Grant Solicitation for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program. This particular ARB solicitation is for Off-Road Advanced Technology Demonstration Projects.

VeRail will upgrade its current VR21C4-nz near-zero emission natural gas switcher locomotive, that is currently being manufactured for a demonstration in the ports of Los Angeles and Long Beach, to zero-emission track-miles capability by using a 2,100 HP battery system. Addition of this battery system will allow the locomotive to operate as either a 2,100 HP VR21C4-nz near-zero emissions locomotive or as a 2,100 HP VR21C-z zero-emission battery switcher locomotive. The battery system is designed to operate for a full eight to nine hour shift thus providing the ability to compare the locomotive operations in zero-emission mode to not only the VR21C4-nz near-zero emission switcher locomotive, but also to compare operation to the current fleet of 14 2,100 HP Tier 3+ diesel locomotives being operated in the ports by Pacific Harbor Line (PHL), who operates the rail switching operations in the ports.

VeRail has already been awarded $1.6 million in grant finding from the South Coast Air Quality Management District ($500,000 of this amount is from Southern California Gas and $500,000 is from the US EPA) and $600,000 from the Ports of Los Angeles and Long Beach (through their Technology Advancement Program) for the manufacturing of the VR21C4-nz locomotive that will be used as the basis for the VR21C-z battery locomotive capability upgrade. The VR21C4-nz project team has fully indicated there is no conflict between the existing project and the proposed upgrade to zero-emission track-mile capability. The requested funding will leverage the experience and benefits gained by the "nz" project to facilitate a first-of-its-kind locomotive demonstration of significant zero emission operation. As part of VeRail's commitment to this battery locomotive project, VeRail will contribute $60,000 in engineering and administration as a cash contribution to the project.

We look forward to working with the Port of Los Angeles on this exciting zero-emission locomotive project. Should you have any questions regarding our support of this project, please do not hesitate to contact me at 513-454-8192 or via email at tmack@VeRail.com.

Sincerely,

Tom Mack

Tom Mack
President and Chief Technology Office

1776 Mentor Avenue, Suite 350 • Cincinnati, OH 45212 • USA • +1-513-454-8192
www.VeRail.com

VOLTABOX®

September 6, 2017

Mr. Chris Cannon
Director of Environmental Management
Port of Los Angeles
425 S. Palos Verdes Street
San Pedro, CA 90733

Dear. Mr. Cannon:

Voltabox of Texas (Voltabox) is pleased to continue its relationship with VeRail by committing to donate one battery pod valued at $159,949 to the Zero-Emission Track-Miles Demonstration project as an in-kind match. Voltabox is the battery supplier for the VeRail VR21C-z demonstration locomotive and looking forward to this opportunity to demonstrate that Voltabox's advanced battery technology can be an effective solution in heavy-duty goods movement service, such as a switcher locomotive.

Voltabox is a pioneer in intrinsically safe high-performance Li-Ion batteries for all types of vehicles and stationary storage systems, with a specialization in heavy-duty applications. Manufactured in the United States, Voltabox batteries are used around the world in heavy-duty vehicle applications, including buses, underground mining equipment, and now locomotives. Voltabox has made significant advancements in Lithium Ion battery system technology and will be supplying a nickel-Manganese-Cobalt-Oxide Lithium-Ion (abbreviated LiNMC or simply NMC) high energy cell battery technology for this demonstration project.

Voltabox of Texas is excited for the opportunity to demonstrate its advance battery technology and be a part of this California Air Resources Board Off-Road Advanced Technology Demonstration Projects.

Sincerely,

Rick Herndon
COO

Signature

American Traction Systems
Electric Propulsion Controls and Accessories
ATS

10076 Bavaria Road
Fort Myers, FL 33913
Phone: 239-768-0757
Fax: 239-561-0274
www.americantraction.com

September 6, 2017

Mr. Chris Cannon
Director of Environmental Management
Port of Los Angeles
425 S. Palos Verdes Street
San Pedro, CA 90733

Dear. Mr. Cannon:

American Traction Systems (ATS) is pleased to continue its relationship with VeRail and the Port of Los Angeles by committing to donate one charge input rectifier for the Zero-Emission Track-Miles Demonstration project at a dollar value of $12,000. ATS is the manufacturer of the high voltage traction control modules and high-voltage battery control modules that will control the voltage and power from the battery system to the traction control modules on the VeRail VR21C-z demonstration locomotive.

ATS is a private, wholly American owned company specializing in the design and manufacturing of high power AC and DC Motor Control products. ATS is excited for the opportunity to demonstrate its high voltage traction control modules and high-voltage battery control modules as a part of this California Air Resources Board Off-Road Advanced Technology Demonstration Projects.

Sincerely,

Larry Machak

Larry Machak
Business Development Manager

TETRA TECH

Eddy Huang, Ph.D.
Vice President

August 31, 2017

Ms. Mary D. Nichols
Chair, California Air Resources Board
1001 I Street
Sacramento, CA 95814

RE: Letter of Commitment for the Port of Los Angeles Zero-Emission Track Miles Locomotive Demonstration

Dear Ms. Nichols,

Tetra Tech team is pleased to support the Port of Los Angeles (POLA) Zero-Emission Track Miles Locomotive Demonstration submission to the Air Resources Board's 2016-2017 Off-Road Advanced Technology Demonstration grant program for funding to demonstrate heavy-duty, zero-emissions, off-road cargo-handling equipment.

As a project partner, Tetra Tech is committed to the success of the proposed project and the completion of all activities assigned to it in the Work Plan. Specifically, Tetra Tech and our subcontractor (UCR CE-CERT) are currently contracted with POLA's As-Needed Air Quality Services Contract, and will be working through that contract to support this demonstration. Tetra Tech team will provide support for data analysis and potentially portable emissions measurement systems (PEMS) testing of an Ultra-low NO_x natural gas and battery electric switcher locomotive at PHL terminal at POLA. If the proposed project receives an award, Tetra Tech guarantees the availability of its staff members for their assigned tasks. Further, Tetra Tech guarantees the availability of any other company resources required to complete the activities assigned to it in the Work Plan for the duration of the project.

Tetra Tech is well suited to its assigned tasks. Tetra Tech and CE-CERT have hands on experience collecting and analyzing data from a range of port equipment. Specifically, our team has developed test plans and duty cycles, selected and installed data collection equipment, conducted emissions testing, analyzed resulting data, and prepared technical reports for several projects in the San Pedro Bay. Our team's relevant experiences include:

- Demonstration of the Capacity PHETT hybrid terminal tractor (the Ports)
- Support of the demonstration of a US Hybrid terminal tractor (the Ports)
- Demonstration and Test Plan of Vision Zero Emission Hydrogen Fuel Cell (the Ports)
- Demonstration and Test Plan of Balqon Electric Class 8 Heavy-Duty Trucks (the Ports)
- PHL demonstration of the "Green Goat" battery-electric switcher locomotive (the Ports)
- PHL demonstration of an LNG-fueled switcher locomotive (the Ports)
- Collection of drayage truck operating data for Drayage Truck Duty Cycle (the Ports)
- Technical Assistance for Alternative and Renewable Fuel and Vehicle Technology (CEC)
- Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (CARB)

Tetra Tech, Inc.
3475 E. Foothill Boulevard, Suite 200, Pasadena, CA 91107-6024
Tel 626.470.2417 www.tetratech.com

TETRA TECH

Eddy Huang, Ph.D.
Vice President

For the Ultra-low NO_x natural gas and battery electric switcher locomotive, Tetra Tech team will process and analyze the collected data to determine activity patterns including hours of operation, days of operation per year, miles traveled per day using GPS data (and associated odometer reading per day and per shift if shift times are provided), average value and distribution of speed and acceleration based on GPS data, and idling time. GPS data can be analyzed to determine the number of trips between specific locations that are related to loading and unloading cargo, and refueling. Tetra Tech team will also analyze the performance of the locomotive in terms of the state of charge (SOC) throughout the work shift (minute-by-minute), fuel/energy consumption rate per work completed/distance driven, and fuel/energy consumption while idling.

Tetra Tech team's cost estimate for data analysis is $100,000. This budget includes: Analysis and summary of the activity data, as specified above, and preparation of a section with a synopsis of all the average performance factors, and comparisons between baseline pieces of equipment and advanced technology pieces of equipment for the final summary report.

Additionally, Tetra Tech team can provide PEMS testing for $70,000. The budget for PEMS testing includes: travel to the site, installation and equipment preparation on-site, and actual testing. PEMS testing will incorporate typical pollutants, including THC, CO, NO_x, and CO_2. Since CH_4 is not typically incorporated into PEMS system, CH_4 emissions will be determined as a percentage of the THC emissions measurements. A PEMS for the measurement of PM will also be included in the testing.

We are very excited about the proposed project and look forward to following its progress. If you have any questions at all about our commitment, please contact me at (626) 470 – 2417, or email me at eddy.huang@tetratech.com.

Sincerely,

Eddy Huang

Eddy Huang, Ph.D.
Vice President
Tetra Tech, Inc.

Tetra Tech, Inc.
3475 E. Foothill Boulevard, Suite 200, Pasadena, CA 91107-6024
Tel 626.470.2417 www.tetratech.com

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 · www.aqmd.gov

Matt Miyasato, Ph.D.
Science and Technology Advancement
909.396.3249 mmiyasato@aqmd.gov

September 5, 2017

Mr. Nathan Dean
California Air Resources Board
Mobile Source Control Division
9480 Telstar Avenue
El Monte, CA 91731

Dear Mr. Dean:

South Coast Air Quality Management District (SCAQMD) staff is pleased to provide this letter of commitment in support of the Port of Los Angeles (POLA) Zero Emission Track-Miles Locomotive Demonstration Project application, submitted in response to the Low Carbon Transportation and Fuels investments and the Air Quality Improvement Programs (AQIP) Fiscal Year 2016-17 Off-Road Advanced Technology Demonstration Projects Solicitation.

POLA, the Los Angeles Department of Water and Power, VeRail Technologies, Pacific Harbor Line, Voltabox of Texas, and others have teamed to demonstrate an advanced zero emission battery powered switcher locomotive throughout the Ports of Los Angeles and Long Beach. The switcher locomotive combines a 14-pod battery bank, which supplies adequate energy for a typical 8-hour working period without re-charging and a near-zero natural gas Genset as a range extender for local short haul duties.

SCAQMD is committed to supporting POLA and the project team to successfully implement and complete the project. We believe the project implements parts of the Ports' Clean Air Action Plan and demonstrates a practical and economically viable solution to simultaneously reduce both criteria and CO_2 emissions from port-related rail transportation activities. Technologies that can deliver both of those benefits while fitting easily into existing goods movement operations and infrastructure are much needed.

The South Coast Air Basin is classified as an "extreme" nonattainment area for ozone under the federal Clean Air Act. A wide-scale deployment of low- and zero-emission on-road technologies will be a critical step toward achieving the air quality standards with considerable public health benefits for our region, especially in disadvantaged communities that are disproportionately exposed to harmful diesel emissions. Furthermore, greater deployment of such technologies is expected to not only reduce criteria pollutants, but also provide significant greenhouse gas benefits, reduce California's use and dependence on petroleum transportation fuels, implement the Sustainable Freight Action Plan and develop additional options for the state's goal on establishing more stringent heavy-duty engine standards.

Cleaning the air that we breathe...

Mr. Nathan Dean -2- September 5, 2017

SCAQMD staff strongly urges the ARB to fund the proposed project, and should it be awarded, commits to working with the project partners to identify the most valuable role for the SCAQMD, which may include cost-sharing up to $300,000, pending approval by our Governing Board.

Sincerely,

Matt Miyasato, Ph.D.
Deputy Executive Officer

MMM:NB

September 5, 2017

Jack Kitowski, Chief, Mobile Source Control Division
California Air Resources Board
Mobile Source Control Division
9528 Telstar Avenue
El Monte, California 91731

Dear Mr. Kitowski:

The Los Angeles Department of Water and Power (LADWP) is pleased to continue its relationship with the City of Los Angeles Harbor Department (Port of Los Angeles) by committing to assist with the Port of Los Angeles *Zero-Emissions Track-Miles Locomotive Demonstration Project.* As sister departments within the City of Los Angeles, LADWP has provided power to the Port of Los Angeles throughout its existence, and have joined together on several major development and demonstration projects in the last few years. LADWP is proud to join with the Port of Los Angeles on its proposed project, presented in response to the California Air Resources Board's Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program solicitation for Off-Road Advanced Technology Demonstration Projects.

We understand that the Port of Los Angeles is proposing to demonstrate a zero-emission track-mile switcher locomotive in partnership with VeRail Technologies, Pacific Harbor Line, the South Coast Air Quality Management District. The proposed project would demonstration the VeRail VR21C-Z, a zero-emission battery powered switcher locomotive design, capable of supporting the 2,100 horsepower requirements for full operational capability throughout the PHL network of in-harbor track lines. An advanced technology, the 14-pod battery bank, rated at 1,820 kW-hours, will supply enough energy for a typical 8-hour working period without charging, and electric charging infrastructure will be installed to support the demonstration unit at the PHL facility in Wilmington, CA.

If the Port of Los Angeles' project is funded, LADWP plans to join the project team as a Technical Advisor for the design and installation of utility infrastructure. LADWP staff will work cooperatively to facilitate good design process for the electrical infrastructure installation, provide expert analysis and feedback on data results, and assist with any future estimations or projections. We thank you for your consideration of this project. Please contact me at 213-367-6019 if you have any questions.

Sincerely,

Tomy Giang
Electrical Engineering Associate

Coalition For A Safe Environment
1601 N. Wilmington Blvd., Ste. B, Wilmington, CA 90744
www.cfasecares.org 424-264-5959 310-590-0177
jesse@cfasecares.org jnm4ej@yahooo.com

September 5, 2017

Port of Los Angeles
Environmental Management Division
Los Angeles Harbor Department
425 S. Palos Verde St.
San Pedro, CA 90733

Re: CARB Off-Road Advanced Technology Demonstration Project
Su: Letter of Commitment For Port of Los Angeles Near-Zero Emission Switcher Locomotive Proposal

CARB:

The Coalition For A Safe Environment submits our Letter of Commitment to participate in the Port of Los Angeles Near-Zero Emission Switcher Locomotive Project Proposal. This project entails the adding of batteries to a natural-gas switcher locomotive so that its on-board energy storage system can operate at zero emissions for 7-8 hrs. on electric battery power for part of its traditional work day shift. This has never been done before and will provide proof that zero emission switcher locomotives are feasible for short-term cargo and container transport work shifts and possible for long-term work shifts in the future as battery technology advances.

The Port of Los Angeles is the largest container port in the United States and the Environmental Justice Communities of Wilmington and San Pedro which border the Port of Los Angeles recognize the need to invest in new emerging technologies and to think out-of-the-box for creative ideas to solve our states ambitious goals to significantly reduce air pollution and greenhouse gas emissions. We support the Governors executive order for California to transition to zero emissions freight technologies.

Our EJ Communities recognize that when we reduce air pollution and greenhouse gas emissions we will see a significant improvement in public health and a significant decrease in California's current $ 2 billion in annual public health care costs attributed to goods movement.

The Coalition For A Safe Environment (CFASE) is a community based non-profit environmental justice, public health and public safety advocacy organization. CFASE is primarily a Latino EJ Organization founded in 2001 by a Wilmington resident Jesse N. Marquez. CFASE has been a member of numerous state, regional and local governmental agency committees on ports, freight transportation, goods movement transportation corridors, air quality plans, air pollution monitoring, ship electric shorepower, emissions capture and treatment technologies.

CFASE has additionally conducted its own community based scientific research on zero emission and near zero emission technologies status, emissions capture & treatment technologies, community fenceline air pollution monitoring, toxic water sampling, breast cancer research with UCLA and conducted door-to-door community public health surveys.

CFASE is one of the leading California Environmental Justice Organizations on:

International Trade Ports:	Design, Operations, Equipment & Logistics
Freight Transportation:	Zero Emission Technologies & Near Zero Emission Technologies for Trucks, Trains, Cargo Handling Equipment (CHE) and Ships. Ship, Truck, Train & CHE Emissions Capture & Treatment Technologies. Air Quality Monitoring, Fence-Line Monitoring & Field Testing

CFASE is involved in eliminating, reducing and mitigating air pollution, land contamination, water contamination and global warming caused by international trade marine ports, freight transportation, goods movement transportation corridors, warehouse-distribution centers, petroleum and energy industries.

CFASE has the technical knowledge, emissions testing and analysis expertise to assure the success of this new technology demonstration project. The benefits to our Environmental Justice Community include:

- Support for wise investment of public funds for emerging technologies
- New technology job creation in Los Angeles & Harbor EJ Communities
- Significant reduction of all categories of criteria pollutants & toxic pollutants
- Significant reduction of greenhouse gases
- Significant reduction in locomotive noise
- Reduction in diesel fuel transport & storage safety risk in our community
- Less petroleum exploration, drilling & refining in Harbor EJ Communities
- Less import of crude oil & refined fuels, storage and transport in our Harbor EJ Communities
- Prevention of micro-climatic impacts in Harbor EJ Communities
- Reduction of short term & long term public health impacts
- Evidence that community-based EJ Organizations are capable of partnering with ports.

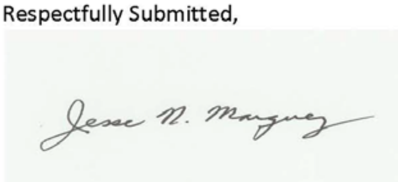
Wilmington is classified as a Disadvantaged Community according to AB 1550, SB 535 and by CalEPA/California Air Resources Board according to OEHHA CalEnviroScreen 3.0. When looking at one typical Wilmington borderline census track #6037294830 to the Port of Los Angeles the CalEnviroScreen Percentile is 96% -100%, the Pollution Burden Percentile 89 and the Population Characteristic Percentile 95.

CFASE can provide the following services in support if the project:

Project Team:	Project Goals Accomplishment, Field Demonstration Planning, Test Protocol Design, Data Collection, Project Status Report & Final Project Report Review
Emissions Testing:	Equipment Selection, Equipment Calibration Validation, Emissions Data

	Collection, Emissions Data Analysis, Data Reporting, Testing Witness
Photography/ Videography:	Still Digital Photography, Videography, Photo/Video Editing, Photo Printing, Photo/Video Duplication USB Memory Drive, CD, DVD
Public Relations	Community Meeting/Event Attendance, Public/Community Presentations, Power Point Presentation Design, Flyer/Brochure/Poster Design, Printing & Distribution, Press Events Coordination & Participation

Respectfully Submitted,



Jesse N. Marquez
Executive Director

ATTACHMENT 9: APPLICANT QUALIFICATIONS

1. Qualifications Narrative:

The City of Los Angeles Harbor Department (Harbor Department or POLA) has extensive experience developing, implementing, and administering technology demonstrations and projects that require detailed and active project management and coordination with technology providers, equipment and vehicle manufacturers, equipment operators, as well as other project stakeholders. In addition to the related information provided in Attachment 1, Subsection 1, the following projects demonstrate the Harbor Department's proven ability to efficiently and effectively implement the proposed POLA Zero-Emission Track-Miles Locomotive Demonstration project.

The Ports of Los Angeles and Long Beach's landmark joint Clean Air Action Plan (CAAP) guides the Harbor Department in its commitment to reduce the health risks and air emissions associated with port-related operations, while allowing port development and growth to continue. A key element of the CAAP is its Technology Advancement Program (TAP), which works to accelerate the verification and commercial availability of emission reduction technologies to move towards an emissions free port. Active since 2007, the TAP has considered numerous technology proposals covering a broad range of different port sources, ultimately approving 30 projects for TAP funding. Below is a list of key TAP projects that were successfully completed:

- Balqon Lithium-Ion Battery Demonstration (2011)
- Capacity Plug-In Hybrid Electric Terminal Tractor (2010)
- Characterization of Drayage Truck Duty-Cycles (2011)
- Development of a Drayage Truck Chassis Dynamometer Test Cycle (2011)
- Hybrid Yard Tractor Development & Demonstration (2010)
- Hybrid Yard Tractor Development & Demonstration – Beta Test (2011)
- Johnson Matthey Locomotive DPF Demonstration (2014)
- Long Beach Container Terminal Eco-Crane™ (2011)
- SCAQMD HDV In-Use Emissions Testing Program (2013)
- TransPower Electric Drayage Infrastructure and Improvement (EDII) Project (2016)
- TransPower Electric Drayage Pre-Commercial Truck Demonstration (2016)
- US Hybrid On-Board Charger for Zero Emission Cargo Transport Demonstration (2016)
- VYCON REGEN® System for Rubber-Tired Gantry Cranes Testing & Verification (2007)

In addition to the TAP, the Harbor Department has a number of other important projects that demonstrate POLA's ability to manage and complete a number of important technology development and demonstration projects:

- *Electric Yard Tractor Demonstration Project* – In 2013, the Harbor Department was awarded $1 million from ARB's AB 118 Air Quality Improvement Program to integrate TransPower's electric drive technology into two off-road yard tractors. The two yard tractors are currently being demonstrated by port tenants. The project was completed in May 2015.
- *Cargo Handling Equipment Retrofit* – The Harbor Department was awarded $469,000 from the 2013 Defense Evaluation and Research Agency program to retrofit 14 pieces of cargo handling equipment with diesel particulate filters. Projects are on schedule and reporting is up to date.
- *Shore Power Program* – In 2012, the Harbor Department was awarded $23.5 million by ARB to co-fund shore power installation. All 10 berths were completed by November 2014.
- *Early Shore Power* – USEPA awarded $1.2 million in June 2010 to supply electricity generated from a Flex-Grid System to container vessels while at berth. The final report was accepted by USEPA.

- *Eco-Crane* – U.S. Environmental Protection Agency (USEPA) awarded a $731,298 Emerging Technologies grant to the Harbor Department to demonstrate the Eco-Crane, a diesel-electric hybrid rubber tire gantry crane.
- *Vehicle Retrofits* – In 2009, USEPA awarded $2 million from the American Recovery and Reinvestment Act to retrofit 27 vehicles including harbor vessels, trucks, sweepers, loaders, cranes, and forklifts. The final report was accepted by USEPA.

The Harbor Department has 27 active cooperative agreements with the Transportation Security Authority and Federal Emergency Management Agency (FEMA) valued at $78 million, as well as 35 other federal and state grants. All government grants active at this time total over $361 million. The Harbor Department is consistent in its quarterly reporting and has successfully completed cooperative agreements with approved final reports submitted on time. In addition, the Harbor Department has a long history of implementing successful government grant partnerships. These include:

- The Air Quality Mitigation Incentive Program (AQMIP), The Air Quality Mitigation Incentive Program (AQMIP), a $29 million program that provided grant funding to port operators to reduce emissions that are surplus to existing regulations or other mandates. A wide range of projects have been implemented under the AQMIP, including marine vessel and cargo handling equipment repowers, truck and non-road equipment replacements, diesel emission reduction retrofits, and a number of innovative research and development projects.
- The Vessel Main Engine Fuel Incentive Program, which provided monetary incentive for the use of low-sulfur marine fuel in vessel main engines prior to state regulation.
- In July 2012, the Harbor Department launched the Environmental Ship Index Program (ESI) to provide incentives to ships that obtain certain clean ship scores using an international rating system developed through the International Association of Ports and Harbors and World Ports Climate Initiative.
- The Harbor Department successfully manages the Vessel Speed Reduction (VSR) Program, an incentive program for vessels to reduce speeds in the designated VSR zone. In 2016, the compliance rate was 92% at 20 nm and 80% at 40 nm.
- The Harbor Department, as part of CAAP, oversees the Clean Truck Program, which calls for drayage truck owners to replace about 16,000 polluting trucks working at the ports, with the assistance of a port-sponsored grant or loan subsidy. The Harbor Department has contributed close to $70 million in funding to the Clean Truck Program, including grants.

These programs represent a voluntary, collaborative effort between Harbor Department and equipment owners and technology providers that spans decades. In addition, these projects demonstrate the Harbor Department's ability to successfully implement cooperative agreements, manage resources, meet reporting requirements, evaluate projects/initiatives, and document progress. Its extensive history implementing grant projects from both sides (grantor and grantee) uniquely positions the Harbor Department for this proposed project in that it has both managed and implemented technology development and demonstration programs for zero-emission vehicles and equipment.

2. Staff Information

The POLA Zero-Emission Track-Miles Locomotive Demonstration Project will be led by senior Harbor Department staff who have administered and managed tens of millions of dollars of grant funded projects.

Name: Christopher Cannon	Hourly rate: NA
Phone: (310) 732-3763	Email: CCannon@portla.org
Title: City of Los Angeles Harbor Department Chief Sustainability Officer	
Expected duties: Project Director – Provides overall leadership and executive oversight for the project.	
Name: Shaouki Aboulhosn	Hourly rate: NA
Phone: (310) 732-3326	Email: aboulhosns@portla.org
Title: Senior Electrical Engineer	
Expected duties: Reviews infrastructure designs and construction specifications to determine compliance with City and Harbor Department building and operational standards.	
Name: Jacob Goldberg	Hourly rate: NA
Phone: (310) 732-2675	Email: jgoldberg@portla.org
Title: Environmental Specialist	
Expected duties: Project Manager/Grant Administrator – Manages the project and oversees grant administrative duties and coordination with ARB throughout the project.	
Name: Tim DeMoss	Hourly rate: NA
Phone: (310) 221-4782	Email: TDeMoss@portla.org
Title: Marine Environmental Supervisor	
Expected duties: Technology Demonstration Lead – Oversees and coordinates technology demonstration partners' participation in the project.	

3. **Subcontractor Information**

Pacific Harbor Line – End User Facility	
Name: Otis L. Cliatt, II	Hourly rate: NA
Phone: (310) 984-5765	Email: ocliatt@anacostia.com
Title: President	
Expected duties: Provide testing platform for Zero-Emissions Track-Miles Locomotive Demonstration project.	
VeRail – Demonstration Locomotive Provider	
Name: Tom Mack	Hourly rate: NA
Phone: (513) 454-8192	Email: tmack@VeRail.com
Title: President and Chief Technology Officer	
Expected duties: Provide locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.	
Voltabox – Battery Provider	
Name: Jay Neutzler	Hourly rate: NA
Phone: (512) 921-4191	Email: jay.neutzler@voltabox.com
Title: Engineering Manager and Mechanical Engineer	
Expected duties: Provide battery and technical support for locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.	
Voltabox – Battery Provider	
Name: Michael Unkelbach	Hourly rate: NA
Phone: +49 5250 9930-985	Email: michael.unkelbach@voltabox.ag
Title: Vice President Research and Development	
Expected duties: Provide battery and technical support for locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.	

American Traction Systems– Battery Control System	
Name: Dr. Anthony (Tony) Davis	Hourly rate: NA
Phone: (239) 768-0757	Email: tdavis@saminco.iml.net
Title: Vice President	
Expected duties: Provide battery control system technical support for locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.	
TMV Control Systems	
Name: Jay Rafferty	Hourly rate: NA
Phone: (814) 856-2120	Email: jrafferty@tmvcontrol.com
Title: System Integration and Field Service Technician	
Expected duties: Provide battery control system technical support for locomotive for Zero-Emissions Track-Miles Locomotive Demonstration project.	
Tetra Tech – Data Collection & Analysis	
Name: Eddy Huang, PhD	Hourly rate: $250/hr.
Phone: (626) 470-2417	Email: eddy.huang@tetratech.com
Title: Director of the Air Quality/Clean Transportation	
Expected duties: Data Analysis Management	
Tetra Tech – Data Collection & Analysis	
Name: Charng-Ching Lin, Ph.D.	Hourly rate: $200/hr.
Phone: (626) 470-2445	Email: Charngching.lin@tetratech.com
Title: Principal air quality specialist	
Expected duties: Technical Lead for Data Analysis	
UC Riverside Center for Environmental Research and Technology – Data Collection & Analysis	
Name: Kent Johnson	Hourly rate: $178.96
Phone: (951) 781-5786	Email: kjohnson@cert.ucr.edu
Title: Associate Research Engineer	
Expected duties: Oversight of data analysis, and reporting	

UC Riverside Center for Environmental Research and Technology – Data Collection & Analysis	
Name: Tom Durbin	Hourly rate: $162.74
Phone: (951) 781-5786	Email: durbin@cert.ucr.edu
Title: Research Engineer	
Expected duties: Assistant project manager for reporting/final report	
UC Riverside Center for Environmental Research and Technology – Data Collection & Analysis	
Name: Kanok Boriboonsomsin	Hourly rate: $157.42
Phone: (951) 781-5792	Email: kanok@cert.ucr.edu
Title: Associate Research Engineer	
Expected duties: Data analysis, reporting/final report	
UC Riverside Center for Environmental Research and Technology – Data Collection & Analysis	
Name: George Scora	Hourly rate: $97.12
Phone: (951) 781-5044	Email: gscora@cert.ucr.edu
Title: Assistant project scientist	
Expected duties: Data analysis, data presentation	
South Coast Air Quality Management District – Technical Advisor	
Name: Matt Miyasato, PhD	Hourly rate: NA
Phone: (909) 396-3249	Email: mmiyasato@aqmd.gov
Title: Deputy Executive Officer for Science & Technology Advancement	
Expected duties: Technical Advisor – Development and commercialization of clean air technologies	

Los Angeles Department of Water & Power – Technical Advisor	
Name: Tomy Giang, Electrical Engineer	Hourly rate: NA
Phone: (213) 367-6019	Email: Tomy.GIANG@ladwp.com
Title: EV Power Distribution and Service Planning	
Expected duties: Technical Advisor – Provides utility advice and energy optimization scenarios	

Coalition for A Safe Environment – Community Advisor	
Name: Jesse Marquez	Hourly rate: NA
Phone: (310) 590-0177	Email: jesse@cfasecares.org
Title: Executive Director	
Expected duties: Community Advisor	

Resumes for the following key people can be found in Appendix A:

Chris Cannon, Director of Environmental Management and Chief Sustainability Officer, POLA
Shaouki Aboulhosn, Senior Electrical Engineer, POLA
Jacob Goldberg, Project Manager and Grant Administrator, POLA
Tim DeMoss, Marine Environmental Supervisor, POLA
Otis Cliatt, II, President, PHL
Tom Mack, VeRail
Jay Neutzler, Voltabox
Michael Unkelbach, Voltabox
Dr. Tony Davis, ATS
Jay Rafferty, TMV
Eddy Huang, Ph.D., Tetra Tech
Kent C. Johnson, Ph.D., CE-CERT
Thomas D. Durbin, Ph.D., CE-CERT
Kanok Boriboonsomsin, Ph.D., P.E., CE-CERT
George A. Scora, Ph.D., CE-CERT
Tomy Giang, Electrical Engineer, LADWP
Matt Miyasato, PhD, SCAQMD
Jesse Marquez, CFASE

ATTACHMENT 10: CONFLICT OF INTEREST DECLARATION

The Los Angeles Harbor Department finds no conflict of interest with its ability to fulfill the necessary duties as the Off-Road Advanced Technology Demonstration Program Grantee. In addition, neither the Harbor Department nor its subcontractors, as identified in Attachment 9 of this application, has any current, ongoing, or pending direct or indirect interest, which poses an actual, apparent, or potential conflict of interest with its ability to fulfill the duties as the Grantee.

ATTACHMENT 11: STD. 204 PAYEE DATA RECORD

State of California—Department of Health Care Services

PAYEE DATA RECORD

(Required when receiving payment from the State of California in lieu of IRS W-9)
STD. 204 (Rev. 5/06)_DHCS

1

INSTRUCTIONS: Complete all information on this form. Sign, date, and return to the State agency (department/office) address shown at the bottom of this page. Prompt return of this **fully completed** form will prevent delays when processing payments. Information provided in this form will be used by State agencies to prepare Information Returns (1099). See reverse side for more information and Privacy Statement.
NOTE: Governmental entities, federal, state, and local (including school districts), are not required to submit this form.

2

PAYEE'S LEGAL BUSINESS NAME (Type or Print) City of Los Angeles Harbor Department	
SOLE PROPRIETOR—ENTER NAME AS SHOWN ON SSN (Last, First, M.I.)	E-MAIL ADDRESS
MAILING ADDRESS 425 South Palos Verdes Street	BUSINESS ADDRESS 425 South Palos Verdes Street
CITY, STATE, ZIP CODE San Pedro, CA, 90731	CITY, STATE, ZIP CODE San Pedro, CA, 90731

3 PAYEE ENTITY TYPE — CHECK ONE BOX ONLY

ENTER FEDERAL EMPLOYER IDENTIFICATION NUMBER (FEIN): 95-6000735

NOTE: Payment will not be processed without an accompanying taxpayer I.D. number.

- ☐ **PARTNERSHIP**
- ☐ **ESTATE OR TRUST**
- **CORPORATION:**
  - ☐ **MEDICAL** (e.g., dentistry, psychotherapy, chiropractic, etc.)
  - ☐ **LEGAL** (e.g., attorney services)
  - ☐ **EXEMPT** (nonprofit)
  - ☒ **ALL OTHERS**
- ☐ **INDIVIDUAL OR SOLE PROPRIETOR**
  ENTER SOCIAL SECURITY NUMBER: ___-__-____
  (SSN required by authority of California Revenue and Tax Code Section 18646)

4 PAYEE RESIDENCY TYPE

- ☒ California resident—qualified to do business in California or maintains a permanent place of business in California.
- ☐ California nonresident (see reverse side)—Payments to nonresidents for services may be subject to State income tax withholding.
  - ☐ No services performed in California.
  - ☐ Copy of Franchise Tax Board waiver of State withholding attached.

5

I hereby certify under penalty of perjury that the information provided on this document is true and correct. Should my residency status change, I will promptly notify the State agency below.

AUTHORIZED PAYEE REPRESENTATIVE'S NAME (Type or Print) Eugene D. Seroka	TITLE Executive Director	
for SIGNATURE Michael DiBernardo	DATE 9/7/17	TELEPHONE (310) 732-3456

6

Please return completed form to:

Department/Office: Department of Health Care Services- TPLRD

Unit/Section:

Mailing Address:

City/State/ZIP:

Telephone: ( ) **FAX:** ( )

E-Mail Address:

State of California--Department of Health Care Services

PAYEE DATA RECORD

STD. 204 (Rev. 5/06)_DHCS (Page 2)

1	**Requirement to Complete Payee Data Record, STD. 204** A completed Payee Data Record, STD. 204, is required for payments to all non-governmental entities and will be kept on file at each State agency. Since each State agency with which you do business must have a separate STD. 204 on file, it is possible for a payee to receive this form from various State agencies. Payees who do not wish to complete the STD. 204 may elect to not do business with the State. If the payee does not complete the STD. 204 and the required payee data is not otherwise provided, payment may be reduced for federal backup withholding and nonresident State income tax withholding. Amounts reported on Information Returns (1099) are in accordance with the Internal Revenue Code and the California Revenue and Taxation Code.
2	Enter the payee's legal business name. Sole proprietorships must also include the owner's full name. An individual must list his/her full name. The mailing address should be the address at which the payee chooses to receive correspondence. Do not enter payment address or lock box information here.
3	Check the box that corresponds to the payee business type. Check only one box. Corporations must check the box that identifies the type of corporation. The State of California requires that all parties entering into business transactions that may lead to payment(s) from the State provide their Taxpayer Identification Number (TIN). The TIN is required by the California Revenue and Taxation Code Section 18646 to facilitate tax compliance enforcement activities and the preparation of Form 1099 and other information returns as required by the Internal Revenue Code Section 6109(a). The TIN for individuals and sole proprietorships is the Social Security Number (SSN). Only partnerships, estates, trusts, and corporations will enter their Federal Employer Identification Number (FEIN).
4	**Are you a California resident or nonresident?** A corporation will be defined as a "resident" if it has a permanent place of business in California or is qualified through the Secretary of State to do business in California. A partnership is considered a resident partnership if it has a permanent place of business in California. An estate is a resident if the decedent was a California resident at time of death. A trust is a resident if at least one trustee is a California resident. For individuals and sole proprietors, the term "resident" includes every individual who is in California for other than a temporary or transitory purpose and any individual domiciled in California who is absent for a temporary or transitory purpose. Generally, an individual who comes to California for a purpose that will extend over a long or indefinite period will be considered a resident. However, an individual who comes to perform a particular contract of short duration will be considered a nonresident. Payments to all nonresidents may be subject to withholding. Nonresident payees performing services in California or receiving rent, lease, or royalty payments from property (real or personal) located in California will have 7% of their total payments withheld for State income taxes. However, no withholding is required if total payments to the payee are $1,500 or less for the calendar year. For information on Nonresident Withholding, contact the Franchise Tax Board at the numbers listed below: Withholding Services and Compliance Section: 1-888-792-4900 E-mail address: wscs.gen@ftb.ca.gov For hearing impaired with TDD, call: 1-800-822-6268 Website: www.ftb.ca.gov
5	Provide the name, title, signature, and telephone number of the individual completing this form. Provide the date the form was completed.
6	This section must be completed by the State agency requesting the STD. 204.

Privacy Statement

Section 7(b) of the Privacy Act of 1974 (Public Law 93-579) requires that any federal, State, or local governmental agency, which requests an individual to disclose their social security account number, shall inform that individual whether that disclosure is mandatory or voluntary, by which statutory or other authority such number is solicited, and what uses will be made of it.

It is mandatory to furnish the information requested. Federal law requires that payment for which the requested information is not provided is subject to federal backup withholding and State law imposes noncompliance penalties of up to $20,000.

You have the right to access records containing your personal information, such as your SSN. To exercise that right, please contact the business services unit or the accounts payable unit of the State agency(ies) with which you transact that business.

All questions should be referred to the requesting State agency listed on the bottom front of this form.

APPENDIX A

CHRISTOPHER CANNON
- Director of Environmental Management
- Chief Sustainability Officer

Christopher Cannon is the Director of Environmental Management for the Port of Los Angeles, a position he has held since October 2010. In 2015, he was named Chief Sustainability Officer of the Port.

In this role, Mr. Cannon is responsible for balancing commerce and growth with ecological sustainability and social responsibility at the nation's busiest container port. The Environmental Management Division provides full environmental services related to water, soils and sediments, air and biological resources, and is responsible for preparation of environmental impact assessments mandated by state and federal law; special studies involving dredging, noise abatement, water quality and air quality; site restoration, remediation and contamination characterizations; wildlife management; and establishment of policies regarding environmental quality issues.

Mr. Cannon first worked at the Port of Los Angeles as a consultant, starting in 2004, where he worked with the Port Environmental Management Division's Air Quality and CEQA groups, supporting the development of key air projects such as the Clean Air Action Plan as well as the Harbor Department's efforts to complete critical environmental impact reports for Port-related projects. In 2008, he helped to develop and served as the Project Manager of the Port's highly successful Clean Truck Program.

Mr. Cannon has 21 years of experience in the environmental services industry, working on a range of projects while employed by ENVIRON International Corporation and TRC Environmental Solutions.

Mr. Cannon also spent two years as a legislative assistant for environmental policy on the Washington, D.C. staff of U.S. Representative Martin Sabo of Minnesota.

Cannon received a bachelor's degree in international relations from Dartmouth College and a law degree from University of California at Berkeley's Boalt Hall School of Law. He currently lives in Los Angeles.

Shaouki Aboul Hosn
Port of Los Angeles
Senior Electrical Engineer II
425 South Palos Verdes Street
San Pedro, CA 90731
Office: (310) 732-3326
e-mail: aboulhosns@portla.org

EDUCATION: Bachelor of Science in Electrical Engineering.
Graduate in 1986 from University of Washington

EXPERIENCE: Electrical Engineer at Port of Los Angeles from April 1987 to present
Technical Experience:

1- Designed many Terminal projects electrical infrastructures which included Hi Voltage (34.5KV/4.16KV) electrical services, substations, power distribution to various loads and low voltage distribution system to reefers, buildings, lighting and power equipment
2- Designed electrical system for commercial buildings, which included power, communication, equipment power, lighting and energy compliance.
3- Designed many shore to ship (AMP) connection projects, where we provided the high voltage infrastructures, established communication protocol with ship, and ensured transferring power to ship thru paralleling power source
4- Designed electric vehicle charging stations for Port's Construction and Maintenance
5- Assist in electrical specifications for Port 's projects to ensure quality products and compliances with port's standards
6- Construction support in reviewing shop drawings, resolving construction issues and verifying in field that construction work is per Port's design and construction standards
7- Review consultant infrastructure design for quality assurance and compliance with project requirements.

Management Experience:

1- Two years project manager for Pier 400 AMP projects with total construction cost of $35M. Project consisted of scheduling, cost estimate, coordinate with various disciplines and tenant, staff meeting, and construction support
2- Supervise (4) electrical subordinates. Supervision consists of assigning projects with clear tasks and schedule, provide training, staff meetings, Monitor projects' progress and support, Evaluate employees, and implement management assignments and goals

GOLDBERG, JACOB

425 S. Palos Verdes Street | San Pedro, CA, 90731 | (310) 732-2675 | jgoldberg@portla.org

WORK EXPERIENCE

Environmental Specialist I — Oct. 2015 to Present

Port of Los Angeles, Environmental Management Division

- Technical Project Manager for Port of Los Angeles Marina Engine Exchange Incentive Program, Annual Municipal Greenhouse Gas Inventory, VeRail Low-NO_x Locomotive Demonstration, HLT Low-NO_x Drayage Truck Demonstration
- Project Manager for all rail-related projects, coordinate with rail companies and technology developers to develop incentive programs and demonstration projects
- Identifying, researching, and assisting with applications for grants, assisted with application for recently received grant from California Energy Commission to demonstrate 25 zero and near-zero emission yard tractors.
- Data analysis and research

Jun. 2014 to Oct. 2015

Student Professional Worker

Port of Los Angeles, Environmental Division

- Responsible for managing the "Marina Engine Exchange" program.
- Responsible for compiling and processing the Port's annual Greenhouse Gas Inventory.
- Data-entry and analysis work

Volunteer — Sep. 2011 to Dec. 2014

California State University, Long Beach Shark Lab

- Undergraduate volunteer, assisted on various graduate student projects.
- Work on acoustic telemetry, seine nets, data logging, and GPS systems.

EDUCATION

Masters of Science, Environmental Science (*In progress*) — Fall 2015-Present

Loyola Marymount University

Bachelor of Science, Marine Biology

January, 2015

California State University, Long Beach

TIM De MOSS

28518 Vista Madera, Rancho Palos Verdes, California 90275

Phone: (310) 221-4782 E-mail: tdemoss@portla.org

WORK EXPERIENCE

MARINE ENVIRONMENTAL SUPERVISOR

Port of Los Angeles, Environmental Management Division June 2014 - Present

- Supervises the Air Quality Section with the major focus of reducing air pollutant emissions from the 5 major sources (Ocean Going Vessels, Heavy Duty Vehicles, Cargo Handling Equipment, Locomotives and Harbor Craft) that move freight in and out of the Port of Los Angeles.
- Zero Emissions Project Manager since June of 2013. Duties involve studying, recommending, implementing, and demonstrating near zero and zero emission equipment in and around the Port complex.
- Project Manager for the preparation of the Port of Los Angeles Zero Emission White Paper
- Assists in the development of Port policy for major air quality programs with the regulatory agencies including the California Air Resources Board's (ARB) Sustainable Freight Strategy Program, ARB's reduction of greenhouse gases Cap and Trade Program, and the South Coast Air Quality Management District (SCAQMD) Air Quality Management Plan

ENVIRONMENTAL SPECIALIST III

Port of Los Angeles (POLA), Environmental Management Division May 2007 – June 2014

- Clean Truck Program Manager since October of 2010. Duties involved managing the implementation, monitoring and enforcement of the program.
- Managed POLA's private consultants in order to complete various air quality projects.
- Maintained a professional link of communication with members of the ARB, SCAQMD, private consultants, business contractors, environmental advocacy groups, and Port of Long Beach staff.
- Prepared various Division Memos, Board Reports, and Letters.

ENVIRONMENTAL SPECIALIST II

Los Angeles World Airports (LAWA), Environmental Management Division January 2005 – May 2007

- Project Manager for Air Quality projects. Duties involved researching air quality and environmental compliance regulations, coordinating regulatory compliance projects for all 4 LAWA Airports, and representing LAWA on annual and periodic SCAQMD audits of LAWA facilities.

SANITARY ENGINEERING ASSOCIATE II

City of Los Angeles, Bureau of Sanitation, Various Divisions June 1991 - January 2005

- Worked in the Wastewater Capital Improvement group managing funding for Capital Improvement projects.
- Worked in the Regulatory Affairs Division's Permits group managing various Water Quality projects.
- Worked in the Human Resources Development Division's Safety group managing various Hazardous Waste/Materials projects.
- Worked in the Recycling and Waste Reduction Division managing various Recycling projects.

EDUCATION

LOYOLA MARYMOUNT UNIVERSITY, LOS ANGELES, CA August 2000

- Master of Science in Civil Engineering with emphasis on Environmental Science

  Course work: Air Pollution Analysis, Environmental Engineering and Science Laboratory, Aquatic Chemistry, Principals of Water Quality Management

LOYOLA MARYMOUNT UNIVERSITY, LOS ANGELES, CA May 1991

- Bachelor of Science in Civil Engineering

  Course work: Analytical Methods in Civil Engineering, Introduction to Environmental Engineering, Water Resources Planning and Design, Water and Wastewater Treatment

Otis L. Cliatt, II

President – Pacific Harbor Line, Inc.

Otis Cliatt joined PHL as vice president July, 2010 and was appointed as President on Oct 1, 2012. Otis' responsibilities include; establishing and managing PHL's annual budget - Profit & Loss, overseeing operational planning, building & maintaining customer relations, equipment purchase, infrastructure upgrades, growth, establishing safety culture, negotiating union contract, and continually seeking technological advancement.

Otis, a combat veteran (1987-1995) received a Bronze Star for actions in Desert Storm, Otis served a total of 8yrs in the US Army's elite Special Operations Command (SOCOM) @ Ft Bragg, NC (active duty) and 20th Special Forces Group @ Camp Blanding, FL (National Guard duty).

Upon completing military duty Otis began his career in the railroad industry (1993-Present). Otis began w/Union Pacific Railroad–UPRR from 1993-2000 in the Management Development Program, a program that encompassed all aspects of the railroad industry in various locations. Otis held a variety of leadership positions in operations and safety, from managing large classification hump yards with up to 300 terminal employees to smaller road territories located within a 250 mile radius of one another.

After UPRR, Otis held leadership positions with CANAC, Inc., an industrial rail switching subsidiary of Canadian National Railway from 2000–2005 as Regional Vice President where he was an integral part in the implementation of Remote Control Locomotives within Canada & US. Otis led a region encompassing 10 Industrial Rail Operation sites in an 8-state geographical area totaling over 250 employees.

Education

- 1987 - Florida A & M University, Bachelor of Science in Business Economics w/minor in Labor Relations
- 1993 – Union Pacific Railroad's 12-month Management Development Program
- 2013 - CPE Certified Port Executive Program – Engineering Institute of Canada
- 2015 - UCLA Anderson School of Management – Executive Program – Certificate

Affiliations/Community Involvement

- Board of Directors (West), American Short Line and Regional Railroad Association
- National Chairman of Veterans Recruitment Committee for American Short Line and Regional Railroad Association-ASLRRA
- Board of Directors (Treasurer), California Short Line Railroad Association
- Board of Directors, Kappa Alpha Psi, Irvine-Anaheim Alumni Chapter
- Past Board of Directors (Secretary), Education and Charities Foundation of Houston
- Past member of Junior Achievement (Shreveport, LA and Houston, TX)

Personal

Otis and his wife Allison live in Southern, CA. They have one son in college.

Pacific Harbor Line, Inc. an Anacostia & Pacific Company, Inc. provides rail transportation, maintenance and dispatching services to the Ports of Long Beach and Los Angeles, which together form the largest container port in the North America. In addition to switching over 40,000 units of carload freight annually, PHL provides rail switching services for nine on-dock intermodal terminals handling over 2 million containers annually and provides dispatching services for about ninety intermodal or unit trains per day.

Pacific Harbor Line, Inc.
705 N Henry Ford Ave
Wilmington, CA 90744
310-984-5765
ocliatt@anacostia.com
www.anacostia.com

TOM MACK

9711 Sycamore Trace Court • Blue Ash, OH 45242 • 513-984-8855 • 513-458-9192 cell
e-mail: thommack@yahoo.com

CAREER SUMMARY

September 2013 to Present: President and Chief Technology Officer, VeRail Technologies, Inc.

Professional with 30+ years experience in consulting, sales, and design/development

Industry Affiliations: serves as Chairman of the Locomotive Maintenance Officers Association (LMOA) Locomotive Software and Systems Committee. Has authored three white papers for the LMOA: one on alternative fuels and hybrid drive systems for locomotives, a second white paper on locomotive tractive effort and adhesion, and the third on natural gas locomotive technology. Working on a fourth white paper on natural gas storage, refueling, and economics for natural gas locomotives. Also serves on American Short Line and Regional Railroad (ASLRRA) Mechanical Committee.

High knowledge level of locomotives and the locomotive industry; intimately familiar with products from all major diesel locomotive manufacturers present and past (EMD, GE, Alco as well as Baldwin, F-M, Lima) both domestic and export (with particular knowledge of South American and Indian railways), mainline (SD's, GP's, SW's, GE Dash 7/8/9, etc.) to industrial locomotives (EMD SW's, Alco S's, GE centercabs and endcabs; rebuilds)

> Ability to identify locomotive models by sight and know corresponding mechanical details such as engine manufacturer/type, traction motors, generators, quirks, pros and cons of design, etc.

Familiar with locomotive parts, engine types, engineering terms, electrical diagrams, and other locomotive related subjects both current and historical

> My knowledge of historical designs and concepts is especially significant for rebuild projects and design and development of new technology locomotives

Business-to-business and personal relationships with many locomotive parts suppliers

Intimate knowledge of new "green" locomotive designs and concepts including alternative fuels, hybrid systems, multi-genset, IGBT solid state controls, and electrically controlled auxiliaries (air compressors, cooling fans, etc.)

Comfortable with presenting to end-users as well as C-level executives in both a management and consultative role.

> Personally know many of the Chief Mechanical Officers (CMO's) and other high-level locomotive officials on Class I railroads, large short line conglomerates, and medium to small short lines

> Comfortable around both the executive meeting room table or shop lunch room table

Multi-year experience interacting and dealing with government lawmakers and officials (U.S. Senators and Congressmen), as well as federal and state government departments (DOE, DOT, FRA, Ohio DOT, California Air Resources Board) and commissions (Ohio Rail Development Commission, California Energy Commission), and international clientele (India, Brazil, Colombia, Bolivia, Chile, Europe).

> Experience dealing with international railroads such as Indian Railways and meeting with members of the railroad, Railway Design Standards Organization (RDSO), and government Railway Board

Working knowledge of major Brazilian and South American railroads and infrastructure. Consulting, locomotive design, and sales experience for both line haul and industrial locomotives for South America.

Experienced national and international speaker on locomotive technologies and trends

Speaking engagements at international conferences in Australia and England on topics of future trends in locomotives technologies, including IGBT traction control systems, hybridization, and use of alternative fuels

Multiple presentations at Locomotive Maintenance Officers Association (LMOA) and American Short Line and Regional Railroad Association (ASLRRA) annual conferences highlighting new locomotive technologies

Proven skills in management, financial development, strategic planning, sales, and plan execution. Ability to work with all aspects of outside sales. Skilled in understanding internal engineering issues and sales cycles, and extremely effective in defining and communicating competitive advantages for products and services. High-energy, entrepreneurial player with solid record of achievement. Demonstrated ability to analyze complex situations and develop practical solutions.

PRESENTATION/SPEAKING EXPERIENCE

Speaking Engagements / White Papers

Ethanol Australia Conference – Melbourne, Australia	2007
Future Fuels Rail Traction – London, England (speaker, day chairman)	2008
Battery Council International – Tampa, FL	2008
American Council on Renewable Energy (ACORE)	
WIREC 2008 – Washington, DC	2008
RETECH 2009 – Las Vegas, NV	2009
Railroad Equipment Finance – La Quinta (Palm Springs), CA	2009
Locomotive Maintenance Officers Association – Chicago, IL	2009
Proceedings of the 71st Annual Meeting – September 16-18, 2009, Locomotive Maintenance Officers Association	
White Paper – Ethanol-Electric Hybrid Locomotives	2009
Proceedings of the 74th Annual Meeting – September 22-25, 2012, Locomotive Maintenance Officers Association	
White Paper – Locomotive Tractive Effort and Adhesion	2012
Proceedings of the 75th Annual Meeting – September 22-25, 2013, Locomotive Maintenance Officers Association	
White Paper – Natural Gas Locomotives	2013
ASLRRA 2014 Connections Annual Convention – April 22-25, 2014	
Mechanical Track Presentation – Natural Gas Locomotive Technology	2014
Proceedings of the 76th Annual Meeting – September 22-23, 2014, Locomotive Maintenance Officers Association	
White Paper – Natural Gas Economics and Fueling for Locomotives	2014
ASLRRA 2015 Connections Annual Convention – March 28-30, 2015	
Mechanical Track Presentation – Natural Gas Locomotive Technology	2015
ASLRRA 2016 Connections Annual Convention – April 4-6, 2016	
Mechanical Track Presentation – Locomotive Emissions: Here Toady… But What Tomorrow?	2016

PROFESSIONAL EXPERIENCE

AMERICAN SHORT LINE AND REGIONAL RAILROAD ASSOCIATION (ASLRRA)

Mechanical Committee Member **2013 to Present**

The ASLRRA Mechanical Committee was officially formed in April 2013 at the ASLRRA annual convention in Atlanta, Georgia. Among its responsibilities are:

- Testing of alignment control coupler technology for non-alignment control coupler equipped first generation locomotives
- Dissemination and archiving of locomotive maintenance information, especially for first and second generation locomotives
- Development of mechanical standards and best practices for short line and regional railroads
- Evaluation of new technologies and practices along with education of ASLRRA members on these topics

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION (LMOA)

Chairman – New Technologies Committee **2012 to Present**

Member – New Technologies Committee **2009 to Present**

- Voted Most Valuable Player (MVP) of New Technologies Committee for 2013
- Author of three white papers (fourth in preparation)
    - Ethanol-Electric Hybrid Locomotives (2009)
    - Locomotive Tractive Effort and Adhesion (2012)
    - Natural Gas Locomotives (2013)
- Presenter at LMOA conferences in 2009, 2012, and 2013

FEDERAL RAILROAD ADMINISTRATION (FRA)

Member – Natural Gas Locomotive Work Group **2012 to Present**

The first meeting of the FRA Natural Gas Locomotive Work Group was held at Argonne National Laboratories in Lemont, IL on October 2-3, 2012. The workshop was framed in such a manner as to present the operational and safety constraints currently employed in locomotive engines along with perspectives related to NG usage from different manufacturers, safety regulators, research groups, and the RR industry.

- Active, participating member helping FRA keep abreast of advances in natural gas locomotive technology
- Identify areas of current federal regulations which will require modification or additions to support the adoption of natural gas fueled locomotives (both CNG and LNG)
- One-on-one meetings with FRA to discuss new locomotive technologies and potential issues with current FRA requirements

ASSOCIATION OF AMERICAN RAILROADS (AAR)

Industry Participant – Natural Gas Fuel Tender Technical Advisory Group

(AAR NGFT TAG) 2013 to Present

The AAR NGFT TAG was formed by the AAR and Class I railroads after the FRA formed its Natural Gas Locomotive Work Group. The focus of the TAG is on fuel tender technology, including safety aspects of the fuel tender and connections between the tender and locomotive. Members of the TAG include representatives from every North American Class I railroad.

- Presented to the TAG information on dual fuel (diesel and natural gas) locomotive technology
- Presented to the TAG information on 5,000 PSI high density compressed natural gas (HDCNG) fuel storage systems, refueling methods, and safety

MOTIVE POWER & EQUIPMENT SOLUTIONS, Inc. (MP&ES)
Greenville, SC USA

Internationally known rebuilder and manufacturer of railway locomotives for industrial, switching, and line haul use

Vice President, Sales and Business Development 2011 to 2013

Responsible for managing all aspects of company sales, consulting, and business development

- Developing new locomotives designs using next generation low emissions diesel engines that meet U.S. EPA Tier 3 and Tier 4 as well as EU Stage IIIA emissions standards
- Responsible for developing locomotive and components designs and review of engineering documents
- Responsible for developing working relationships with U.S. railroads (UP, CSX, NS, BNSF, G&W, RailAmerica, and numerous short lines) and international customers (Indian Railways, various South American customers)
- Responsible for developing working relationships with U.S. and international equipment suppliers, including developing specifications for components, reviewing product offerings and designs, evaluating product applicability to design standards, and estimating durability potential of components and their design

ALTERNATIVE HYBRID LOCOMOTIVE TECHNOLOGIES, Inc. (AHL-TECH)
Cincinnati, OH USA

Design and development of the world's first ethanol-electric hybrid locomotives

Founder/President 2005 to 2011

Responsible for managing all aspects of company, and developing company from a concept to an operating entity

- Developed original overall locomotive design and systems for the world's first ethanol-electric hybrid locomotive for U.S. and Indian railroad markets
- Responsible for review of engineering documents and authorizing designs
- Development of detailed monthly Pro Forma to support company growth and investment strategy, and for presentation to investors and grant funding organizations
- Responsible for developing working relationships with U.S. railroads (UP, CSX, NS, BNSF, G&W, RailAmerica, and numerous short lines) and equipment suppliers
- Development of international business relationships, including Indian Railways, and development of multiple European opportunities
- Grant writing and funding identification
- Developed detailed cost analysis and historical fuel pricing model for presentation to California Energy Commission and railroads showing financial impacts of ethanol fueled locomotives compared to diesel fueled locomotives
- Development of investor presentations, business plans, executive summaries, and financial models
- Experience in working with international railroad customers, Railway Boards and suppliers, and setting up international business relationships

JAY K. NEUTZLER — ACCOMPLISHED ENGINEERING MANAGER & MECHANICAL ENGINEER

Leader & Mentor ~ Technology Expert ~ Product R&D thru Production

Accomplished leader with in-depth experience in business growth and engineering management. Bringing premier R&D innovation of mechanical, electromechanical, and electrochemical nature into product reality.
Recognized Skills include:

- ✓ Business Development/Growth
- ✓ Employee/Program Management
- ✓ Customer/Government Interface
- ✓ Hybrid Power & Electrochemical
- ✓ Energy, Automotive, Aero Sectors
- ✓ Budgets, Schedules, & Cash Flow
- ✓ New Product/R&D Launch
- ✓ Product/Systems Design & Integration
- ✓ Product Qualification/Certification/Quality

Prominent contributions in Fuel Cell and Battery Hybrid power. Adept with characterization using Electro Impedance Spectroscopy, potentiostats, and load banks, such as Gamry, Arbin, Hewlett-Packard, for R&D electrode evaluation and battery charge/discharge/cycling response.

EXPERIENCE & NOTABLE CONTRIBUTIONS

ADVANCED GREEN INNOVATIONS • Chandler, AZ • 2013-Present
Pioneering Green Technologies for conversion of Associated "Flare" Gas to Methane & Power.
STAFF MECHANICAL ENGINEER -- SYSTEMS & PROCESS ENGINEERING MANAGER
Providing expert knowledge in New Technology Developments that pertain to the company focus.
KEY ACCOMPLISHMENTS:

- Initiating Mobile/Virtual Pipeline of our Newly Developed “CMT 9000” for the Permian Basin. Working the costing and technical aspects with key suppliers and partners. Entails site reforming of the “Flare” Gas to a Methane rich stream, then blending for BTU and Methane Number (MN) content for Genset Power. Gas Compression for transport and use. Potentially blending up to 1 MMSCFD per CMT 9000.
- Chief Systems Architect for the “CMT 9000” oil well “Flare Gas-to-Power” reformer station. Created process flow & instrumentation (P&ID) and system integration optimization. Designed the Heavy Hydrocarbon and Synthetic Natural Gas Reactors for chemical conversion of the “Flare” Gas to Methane suitable for 1-10MW power generation. Performed process analysis, thermal analysis, component selections, and provided key partnership.

APEX TOOL GROUP • Lexington, SC • 2012-2013
APEX is the premier provider of power and hand tools with over 40 brands for OEM industrial production and the home.
SENIOR STAFF ENGINEER R&D
Next Generation advanced tool development for industrial platforms of pneumatic drilling and high speed electric fastening tools.
KEY ACCOMPLISHMENTS:

- Primary design engineer on new Cleco high speed (30k rpm), high torque (230Nm) 380VDC motor drives for accurate OEM bolting assembly tools with Wi-Fi process control/monitoring. Design & packaging of tool; internals, flex circuit component locations, switch designs, illumination & vibrator user feedback, tool thermal/structural analysis.
- Redesigned reversing clutch and pneumatic elements of Quackenbush™ template-foot drill to increase durability from 30K to 3M cycles; for Boeing 787 “Dreamliner” attachment of exterior skins to the airframe.
- Coordinated global company patent portfolio reviews for technology uniqueness, value, and actions.

NEUTZLER ASSOCIATES, INC. • Palm Beach Gardens, FL & Columbia, SC • 2000-2012
Contracted and direct consulting services fulfilling critical development needs within energy, vehicle, aerospace, and defense.
PRESIDENT
Primary efforts focused on R&D Hybrid Power System utilization. Functional areas include; business development, management, research, design, manufacturing, processing, quality, durability, production, delivery, and contract negotiations.
SIGNIFICANT EFFORTS INCLUDE:

- **South Carolina Research Authority (SCRA) Award & Univ. of South Carolina**, Columbia, SC
  Joined South Carolina’s alternative energy developments at the New Horizon Center of Excellence. Development of Polymer Electrolyte Membrane (PEM) Fuel Cells, Solid Oxide Fuel Cells (SOFC), and system designs. Opportunity to publish, present, and take PhD course work. Fulfilled SCRA residency/business requirements.
- **For Lynntech Inc.,** College Station, TX (Texas A&M Research Park) | *R&D/SBIR business*
  Director of Engineering - Directed engineering efforts of ~50 cross-functional staff and contributed to electromechanical & electrochemical systems, mechanical design and analysis.
  - Generated a 25% increase in revenue in 2 years with new business.
  - Implemented scheduling, budget, performance measures to balance resources across multiple programs.
  - Led efforts to deliver Air Force MB-4 Tow Tractor program in 8 months with 5 core team members. Designed and assembled Hybrid-Electric drive system for drop-in replacement of diesel engine with efficient 30kW PEM Fuel Cell

with Sodium Sulfur battery. Integrated power unit into existing chassis with LED touch-screen display control panel.
- Managed programs and produced new products including; a) Fuel Cell power system for extended flight Unmanned Aerial Vehicles (UAV). b) 20 W Hybrid for soldier power and Micro-Air Vehicle (MAV), c) Sodium BoroHydride hydrogen generator for Multifunctional Handset. d) H_2/O_2 Fuel Cell/electrolyzer Regenerative System power (7kW) for High Altitude Airship (HAA).
- Initiated Quality ISO 9001:2000, continuous process improvement for ISO certification.

- **For Southwest Research Institute,** San Antonio, TX | *State of Texas large scale R&D Institute*
  Sr. Research Engineer – Analytical and Innovation focus.
  - Performed structural non-linear analysis for non-homogeneous composite thin-film hull fabric for Stratospheric Airship (>60,000 ft. altitude) using Pro-E and ANSYS. Support for Avionics definition for airship and regenerative system power analysis for PV cells coupled with Li-ion batteries for control and propulsion. Qualified lightweight triple-junction thin film PV solar cells (2 oz/m2).
  - Patented 180/360° Vision System; mini-multi-lens on a single CCD chip with parallax correction "stereo" vision.
- **Returned to Teledyne Energy Systems, Inc. after Energy Partners' acquisition**, West Palm Beach, FL | *Space Power*
  Technical Manager – Branch Management of the West Palm Beach satellite facility reporting to Hunt Valley, MD HQ.
  - Charged to take-on and deliver the NASA Fuel Cell Power System which was otherwise facing failure, then continued on to win subsequent contracts.
  - Hired and re-established staff and capabilities for new division structure. Coordinated with HQ.
  - Led and delivered NASA advanced PEM Fuel Cell Power System prototype for next generation space flight in 8 months with staff of 15 ($1.3 mil. program). Wrote proposal and won NASA follow-on $4.3 million award to achieve TRL 5.

MOTOROLA LABS • at Los Alamos, NM & Phoenix, AZ • 2000
Motorola's foremost R&D center for new technology development (Dual location).

PRINCIPLE PROJECT MANAGER
Returned to Los Alamos National Laboratory (LANL) to spearhead Motorola Lab's Direct Methanol Fuel Cell (DMFC) program with personnel in both Phoenix and Los Alamos. Coordinated Technology Transfer while stationed at LANL developing ceramic based DMFC system in Phoenix.
- Met annual business goals in 6 months; including 10X increase in DMFC power output resulting in 3 patents.
- Supported proposal efforts resulting with $50 mil Army Research Laboratories (ARL) collaborative award between Honeywell (lead), Motorola, LANL, and MIT.

ENERGY PARTNERS, LLC • West Palm Beach, FL • 1997-2000
Best-in-Class private business focused on transportation and stationary fuel cell power development.

DIRECTOR OF ENGINEERING
Provided technical direction for 50 direct employees and engineering management for all deliverables. Prepared reports, status, and direction for CEO and Board of Directors. Quarterly reviews to the Department of Energy (DOE) & bi-annual to GM/Ford/Chrysler for the Partnership for New Generation of Vehicles (PNGV) to achieve the 80 mpg vehicle.
- Successfully developed programs, partnerships/funding, and personnel affording the firm to effectively double in size in 2 years and readying itself for Acquisition / Initial Public Offering (IPO).
- Program Manager for $7 million DOE PRDA program. Produced many firsts with 50kWnet automotive reformate fuel cell stack and system. Including: MEA performance/characterization with 3M collaborative program; 98% cost reduction with injection molding composite >80% Graphite solids for bi-polar plates.
- Collaborative development with Honeywell to produce 50kW stationary building power.
- Integrated base power system with Gasoline, Natural Gas, and Methanol Reformate reformers from collaborative efforts with Johnson Matthey, IdaTech, and Nuvera/Epyx .

GENERAL MOTORS—GLOBAL ALTERNATIVE PROPULSION CENTER • Rochester, NY • 1995-1997

SENIOR PROJECT ENGINEER
Continued work with LANL yet formally joining GM collaboration efforts for first automotive Fuel Cell system (DOE supported).
- Research and development of the 50 kW automotive Fuel Cell Stack/System including the design/analysis and systems integration of the fuel cell, fuel processor, compressor, humidifiers, heat exchangers, water separators, and layout packaging.
- Development of low-cost fast-response CO sensor device and process for operation resulting in 2 patents.

LOS ALAMOS NATIONAL LABORATORY (DOE) • Los Alamos, NM • 1994-1995

STAFF RESEARCH ASSISTANT
- Researched and developed First Radial Passive-Air PEM fuel cell stack. Conducted diffusion analysis, mechanical design, seal design, thermal/structural analysis, fabrication, performance and durability testing. Brought product rigor into the research for lab pass-off to industry.

Jay K. Neutzler

HONEYWELL AEROSPACE • Glendale, AZ • 1987-1992

Senior Product Engineer

- Aerospace design and development of navigational instruments, indicators, and computers for commercial aircraft and helicopters. Full product responsibility from customer interaction, to schedule/budgets, design, analysis, prototyping, FAA certification, and manufacturing launch. 20 product lines for new development and existing product manufacturing support. Key role in developing "Primus® 2000" the premier "Glass Cockpit" of programmable displays (precursor to "Primus Epic®").
- Customers included; Airbus, Gulfstream, Learjet, Cessna, Dassault, Sikorsky, Bell, Fokker, Dornier, etc.

NORTHROP/WILCOX • Kansas City, MO • 1985-1987

Senior Mechanical Engineer

- Mechanical Design Engineer for ground based Precision Distance Measurement Equipment (DME/P). Company Computer Aided Engineering (CAE) expert and system administrator for mechanical design. Interfaced Numerical Control (NC) milling machine and Sheet Metal punch press software directly to design. Implemented Enterprise Software and "in-house" training for these programs.

HONEYWELL INTERNATIONAL • Kansas City, MO • 1983-1985

Process Engineer

- Implemented Computer Aided Process Planning (CAPP). Programmed expert-knowledge based process procedures on similar grouped parts for optimized Flexible Manufacturing Systems (FMS) and material flow. Utilized zero defect quality policies for nuclear weapons fabrication.

BP-AMOCO RESEARCH CENTER, FUELS RESEARCH DIVISION • Naperville, IL • 1981-1982

BP-Amoco's world research "think-tank" for fuels, plastics, and refining research.

Research Engineer

- Contributed to the research of Drag Reducers in Turbulent Pipe Flow (Fluid Mechanics) resulting in the development of a long chain Polyisobutylene (PIB) which increases flow up to 15% with only a 10 ppm concentration. Developed to increase flow through the Alaskan Pipeline. (Precursor work to "fast fluids" used for fracking today.)
- Redesigned test apparatus and procedures resulting in repeatable testing within .03% SD vs. the previous 3%.
- R&D of wax modifiers for super tankers; to prevent costly entrapment of oil in solidified wax on ship walls.
- Amoco/University of Kansas (KU) cooperative research project. Erosive properties of petroleum coke/water slurries compared to coal/water slurries; intended for coke slurry power generation combustion.

Education

PhD. Candidate in Mechanical Engineering | University of South Carolina | Columbia, SC | 4.0/4.0 GPA | 2011
Advisor, Dr. Kevin Huang, was a protégé of Dr. John Goodenough (UT) recognized founder of Lithium battery technology.
MS in Mechanical Engineering | Arizona State University | Tempe, AZ | 3.9/4.0 GPA | 1995
BS in Mechanical Engineering with Distinction | University of Kansas | Lawrence, KS | 3.6/4.0 GPA | 1982

Software Highlights

CAD Software	Microsoft Office Suite	Engineering Software
Pro/E CREO, Solidworks, AutoCAD	MS Project, Visio, Power Point, Excel	ANSYS, COMSOL, ASPEN, Mechanica

Honors

Golden Key International Honor Society | Pillars of Leadership, Service & Academics | Inducted 2012
Outstanding Innovation Award Recipient | Los Alamos National Laboratory; DOE | 2000 thru 2007, 2010
Industry Reviewer | Annual National Laboratory Merit Review for the Department of Energy | 1999, 2000
Phi Kappa Phi | National Scholastic Honor Society | Inducted 1995
Pi Tau Sigma | National Mechanical Engineering Honor Society | Inducted 1982
Mensa | High Intelligence Quotient (IQ) Society | Since 1980
US Citizen | ITAR qualified | Held Department of Defense "Secret" and Department of Energy "Q" security clearances

400 N Coronado St, Apt 1048 ✦ Chandler, AZ 85224 ✦ 832-498-1230 ✦ jneutzler@aol.com

PATENT LIST

4 Additional US Patents Pending | 46 International Patents | 15 publications | Various Technical Presentations

US 8,836,848 | 2014 | 180/360° Vision System
US 7,638,215 | 2009 | Method of Controlling Delivery of Fuel to a Direct Oxidation Fuel Cell
US 6,981,877 | 2006 | Simplified Direct Oxidation Fuel Cell System
US 6,869,716 | 2005 | Flow Through Gas Separator
US 6,660,423 | 2003 | Direct Methanol Fuel Cell Including a Water Management System and Method of Fabrication
US 6,617,065 | 2003 | Method of Maintaining Neutral Water Balance in a Fuel Cell
US 6,551,736 | 2003 | Fuel Cell Collector Plates with Improved Mass Transfer Channels
US 6,497,975 | 2002 | Direct Methanol Fuel Cell Including a Integrated Flow Field and Method of Fabrication
US 6,207,312 | 2001 | Self-Humidifying Fuel Cell
US 6,180,275 | 2001 | Fuel Cell Collector Plate and Method of Fabrication
US 6,063,516 | 2000 | Method of Monitoring CO Concentrations in Hydrogen Feed to a PEM Fuel Cell
US 6,001,499 | 1999 | Fuel Cell CO Sensor
US 5,776,624 | 1998 | Brazed Bipolar Plates for PEM Fuel Cells
US 5,595,834 | 1997 | Annular Feed Air Breathing Fuel Cell Stack

Michael Unkelbach
Vice President Research & Development

EXPERIENCE

2013 – 2017
BFFT Gesellschaft für Fahrzeugtechnik mbH, Gaimersheim
Head of Energy Storage Systems and Electrification (70 employees)
Projects:

- Development, testing and validation of the Audi C-BEV Traction Battery
- Development of the Li-Ion-Boost-Battery for Audi LMS R18
- Development of a Li-Ion-Starter-Battery for Motorsports
- Research and development of a 3kW isolated DC/DC converter for 1000V

2011 – 2013
BFFT Gesellschaft für Fahrzeugtechnik mbH, Gaimersheim
Project Manager for alternative drive technologies

- Projects:
- Research and development of a Traction Battery for Audi A1 Dual-Mode Hybrid Car
- Research and development of a Traction Battery for Audi A1 e-tron

2009 – 2011
BFFT Gesellschaft für Fahrzeugtechnik mbH, Gaimersheim
Hardware Developer for Audi R8 e-tron traction battery

EDUCATION

2003 – 2009
FH Gießen-Friedberg, Friedberg
Dipl.-Ing. (FH) Electrical Engineering (information and communication technology)

Dr Anthony (Tony) Davis

B.Sc., Ph.D, A.C.G.I, M.I.E.T

Graduated in Electrical Engineering at the Imperial College of the University of London, England and obtained the degree of Doctor of Philosophy at the University of Nottingham, England.

Over 35 years of experience in the design of power conversion equipment and the application of electronic power conversion methods to the control of electromagnetic devices including DC motors, AC motors, linear motors, brushless motors and generators, battery and fuel-cell power sources, mining equipment, rail traction equipment, industrial processes and machine tools.

Currently holds the position of Vice President at Saminco and American Traction Systems. Resident of USA for 16 years.

1974 – 1983
Brush Electrical Machines Ltd, UK
Development engineer, rail propulsion equipment.

1983 – 1992
Control Techniques Drives PLC, UK
Chief Engineer – Research and Development
Development and design of industrial drives and systems.

1992 – 1996
Control Techniques Drives PLC, UK
Technical Director – Manufacturing Division.
Technical responsibility for manufacturing and customer issues.

1996 – 1998
Saftronics Inc.
Vice President – Engineering.
Development and design of industrial drives and systems.

1998 – 2008
Saminco Inc.
Vice President – Engineering
Development and design of electric traction drives and systems.

2008 – Present
Saminco Inc. and American Traction Systems
Director of Engineering
Development and design of electric traction drives and systems.

Jay D. Rafferty

Contact

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Mobile : 814-715-2388
e-mail : jrafferty@tmvcontrol.com

Address

1093 Parks Road, Corsica, PA 15829

Education

1997 to 1999	**Associate in Electrical Engineering Technology** Pennsylvania State University at DuBois, PA: GPA 3.76 with Distinction
1993 to 1995	**Associate in Maintenance Electricity and Construction Technology** Triangle Tech at DuBois, PA: GPA 3.64, with Honors
June 1993	**High School Diploma** Brookville JR./SR. High School

Work Experience

TMV Control System, Cambridge, ON
System Integration and Field Service Technician **June 2013 to Present**

- Control System Integration
  - Specify components and input/output requirements for the integration of the TMV locomotive control system into various applications such as rebuilds, repowers, and new locomotives.
  - Create new locomotive schematics or modify existing schematics for control system installation.
  - Create wire running lists for locomotive builds, rebuilds, and repowers.
  - Detail software requirements per application
  - Design and specify required components for new locomotive high voltage cabinets assembled and wired by TMV Control Systems.
  - Create installation, commissioning, and user documents for control system applications.
  - Assist customers in the trouble shooting of locomotive problems
  - Training on the maintenance and use of the TMV Control System and TMV TECU-PC laptop software.
  - Field Commissioning of locomotives
- Brief sample list of projects:
  - Norfolk Southern SD40-2 locomotives – Control System Integration
  - Norfolk Southern Battery locomotive road# 999 – Control system integration & Battery Management System Testing
  - Herzog MPMs with MTU 2000 Series engine – Control system integration
  - G&W 4-axle mother/mate sets
  - Cummins SD90 road# 1919 – Integrated control system into the first AC traction road locomotive.
  - NCDOT F59PH – Control system integration
  - Knoxville Locomotive Works – Control system integration and design new high voltage electrical cabinets for various KLW locomotive platforms.
  - Brookville Equipment Corp. – Metro North GP35

United Electric Cooperative, DuBois, PA
Meter Technician **Feb 2013 to May 2013**

- Plan, purchase components, and install single and three phase power metering systems.
- Meter testing
- Manage and maintain (PLC) Power Line Communication meter reading system
- Test and maintain substation overcurrent protection

Brookville Equipment Corporation, Brookville, PA
Electrical Engineer **May 2000 to Feb 2013**

- Lead Electrical Engineer for a contract to design and manufacture a quantity of twelve 3600 horsepower diesel electric passenger locomotives for Tri-Rail Commuter Railroad in South Florida.
  - Specify components, design & integrate electrical, pneumatic, and mechanical systems of the locomotive.
  - Assure our design is in compliance with the customer's technical specification
  - Supervise the work of other engineers assigned to the project.
  - Work closely with the drafting department and other engineers in order to prepare accurate drawings for manufacturing.
  - Conduct design review meetings with the customer and their contracted consultants.
- Project Engineer / Project Manager for the design and manufacture of a quantity of three low emission multi engine switch yard locomotives for G&W Railroad.
  - Designed & integrated electrical and mechanical systems of the locomotive.
  - Worked with the drafting department to prepare drawings for manufacturing.
  - Supervised the construction of equipment in the shop, tested the locomotives at our facility and commissioned the units at the customer's facilities.
  - Provided operation and maintenance training to the customer.
  - Provided technical support to the customer.
- Project Engineer / Project Manager for the design and development of a propulsion system for one prototype battery hybrid switch locomotive for Norfolk Southern Railroad, Road Number 999.
- Project Engineer / Project Manager for the design and installation of modern propulsion systems and truck assemblies for a quantity of 24 Perley A. Thomas replica streetcars for the City of New Orleans. The systems were installed and tested under my supervision on site in New Orleans over a period of two years.
  - Managed and supervised on-site labor force (4-5 persons).
  - Managed on-site inventory, shipping/receiving, and scheduling
  - Performed in-process QA/QC inspections of systems and assemblies
  - Performed final testing and troubleshooting of the streetcar
- Design of electrical, hydraulic, and pneumatic systems for various locomotives, mine tractors, and personnel carriers used in the mining industry.
- Provide onsite training, technical support, and troubleshooting to customers in both the mining and railroad industries.
- Frequently prepare presentations, proposals, and quotations for potential customers

Abbott Furnace Company, St Marys, PA
Electrical Engineer **May 1999 – May 2000**

- Designed control panel component layouts and electrical schematics for controlled atmosphere continuous belt electric and natural gas furnaces and heat treaters for the Powdered Metal and Carbon Industries.
- Designed PLC programs using software from a variety of PLC manufacturers such as Allen Bradley, Honeywell, and Siemens.
- Specified and integrated electrical equipment, PLCs, motors, recorders, power supplies, etc to be used in the manufacturing of continuous belt furnaces.

Abbott Furnace Company, St Marys, PA
Electrical Technician **Feb 1995 - May 1999**

- Assembled and wired control panels and components used on controlled atmosphere continuous belt electric and natural gas furnaces, heat treaters, and other miscellaneous equipment used in the Powdered Metal and Carbon Industry.
- Configured and calibrated a wide variety of instrumentation used on industrial equipment, PLCs, Temperature controllers and recorders, variable frequency drives, etc.
- Traveled to customer facilities to provide installation, testing, troubleshooting, and training services.

EDDY HUANG, Ph.D.

Vice President, Air Quality and Clean Transportation **Tetra Tech, Pasadena CA**

EDUCATION/SPECIAL TRAINING

Ph.D., Chemical Engineering (1987)
M.S., Chemical Engineering (1984)
B.S., Chemical Engineering (1979)

YEARS OF EXPERIENCE

Years of Relevant Experience: 31
Years with Tetra Tech: 16

QUALIFICATIONS

Dr. Huang is a Vice President and Director of the Air Quality/Clean Transportation Group at Tetra Tech. Dr. Huang, has the unique combination of air quality expertise, clean transportation program experience, alternative/renewable fuel and vehicle technology experience and large program managerial skills that make him particularly suited to support the POLA As-Needed Air Quality Services. Dr. Huang has been the Project Manager for the POLA As-Needed Air Quality Services since 2005. In addition to the POLA As-Needed Air Quality Services Program, he has years of experience in managing the POLB Professional Air Quality Services Program, the California Energy Commission's (CEC) Technical Assistance for Alternative/Renewable Fuel and Vehicle Technology Program, the POLA and POLB Clean Truck Program, the Port Authority of New York and New Jersey (PANYNJ) Regional Truck Replacement Program, the New York City Department of Transportation (NYCDOT) Clean Trucks Program, the South Coast Air Quality Management District (SCAQMD) Technical Assistance for Advanced, Low- and Zero-Emissions Mobile and Stationary Source Technologies and for Implementation of Incentive Programs, and more than fifty CARB Greenhouse Gas (GHG) Verification Programs.

RELEVANT EXPERIENCE

- **Port of Los Angeles As Needed Air Quality Services, (2005-Present), Principal-in-Charge –** Dr. Huang has provided assistance in evaluation/demonstration of Technology Advancement Program (TAP), support for greenhouse gas emission inventories, review of air quality and health risk assessments of CEQA/NEPA documents, support and tracking of proposed local, state, and federal regulations, permit compliance support for RECLAIM and other stationary sources (SCAQMD) and mobile sources (ARB), assistance in information sharing and outreach to national and international ports, Additionally, he has assisted POLA in international conference hosting, preparation of technical papers and presentations for conferences. (EPA, ARB, and SCAQMD).

- **Port of Los Angeles and Port of Long Beach Clean Trucks Programs, (2008-Present), Program Manager -** Dr. Huang has managed the ground breaking POLA/POLB CTP since 2008. Key program elements include CTP launch in 2008; Concessions and Registration Agreement development, administration and enforcement; temporary sticker access program to facilitate terminal access; establishment of the multi-lingual Terminal Access Center, a toll-free helpline, Clean Trucks Center (for grants processing), and Truck Finance Center; Ports' and State of California grants outreach, processing and administration; web-based Ports' Drayage Truck Registry (PDTR) and DayPass systems; Concessions/Registrations database; annual non-container terminal access sticker program; data systems integration with the Department of Motor Vehicles, eModal, CARB Drayage Truck Registry (DTR), Intermodal Association of North America (IANA), credit card and eCheck processing service, and a Vehicle Identification Number (VIN) validation service; and development of public outreach communications and workshops targeted to key stakeholders. Dr. Huang has successfully accomplished the POLA/POLB CTP goals with on-time and on-budget development, implementation, and administration.

- **California Energy Commission Alternative/Renewable Fuel and Vehicle Technology Program, (2009-2016), Program Manager -** Dr. Huang has supported the CEC in reviewing various fuel and vehicle technologies for potential grant funding opportunities, including Pilot-Scale and Commercial-Scale Advanced Biofuels Production Facilities, Biofuels Early and Pre-Commercial Technology Development, Market Transformation & Viability (MT&V) responses of Advanced Medium- and Heavy-Duty Vehicle Technologies Pre-Commercial Demonstrations, market analysis, economic and financial analysis, technology development, demonstration and troubleshooting, alternative fuel refueling infrastructure development, full fuel cycle, gap analysis, cost benefit analysis and validation of alternative fuel production facility.

- **Port Authority of New York and New Jersey, Regional Truck Emission Reduction Program, (2009-Present), Program Manager -** Dr. Huang has worked closely with PANYNJ staff to develop, implement, and administer the TRP for those fleets that provide regular drayage service to the PANYNJ's Port Newark, Port Elizabeth, Staten Island, and Bayonne terminals. He has led the Tetra Tech team to assist PANYNJ in the TRP development and implementation, oversight and technical support by managing the grant application process; building a network of dealerships and scrapyards to participate in the program; training approved dealerships and scrapyards for TRP compliance; developing participation application forms and agreements and other compliance forms; supporting outreach development and communications; providing stakeholder workshop presentations; interfacing with PANYNJ staff and stakeholders as required to provide program status and information; providing data collection; program reporting, and status updates; collecting and reporting emissions data in compliance with Congestion Mitigation Air Quality (CMAQ) improvement requirements U.S. EPA Diesel Emissions Reduction Act (DERA) reporting.

- **New York City Department of Transportation, Hunts Point Clean Trucks Program, (2011-Present), Program Manager -** Dr. Huang is responsible for the overall program design and implementation ($24 million). Some key tasks include marketing/outreach, database development, truck retrofit/replacement/scrappage program development, rebate application development, CMAQ funding processing, technical evaluation, emission reduction estimation, price point analysis, cost-benefit analysis, and overall program implementation, enforcement and monitoring/reporting.

CHARNG-CHING LIN, Ph.D.

Principal Scientist/Director **Tetra Tech, Pasadena CA**

EDUCATION/SPECIAL TRAINING

Ph.D., Environmental Sciences (1982)
M.S., Environmental Sciences (1979)
M.S., Plant Virology (1974)
B.S., Plant Pathology (1972)

YEARS OF EXPERIENCE

Years of Relevant Experience: 32
Years with Tetra Tech: 6

QUALIFICATIONS

Dr. Lin has experience in various clean trucks program administration, grant administration for truck retrofits, scrappage and replacement. He is familiar with advanced and alternative fuel and vehicle technologies and associated emission benefits. His other experience includes air quality regulatory compliance, permitting, greenhouse gas emissions, stationary source emission measurement and inventory, abatement strategy, mobile source emission measurement, and air quality related pollution prevention opportunity assessment and implementation. Dr. Lin has thirty years of environmental consulting experience for both domestic and international clients. He is knowledgeable in all areas of environmental regulations - air quality, water quality, hazardous wastes, environmental monitoring, health and safety audits.

RELEVANT EXPERIENCE

- **Project Manager, San Pedro Bay Ports Clean Truck Program, San Pedro, CA, Ports of Los Angeles and Long Beach, (2008 – ongoing):** Responsible for concession and grant administration of the Port of Los Angeles Clean Truck Program (CTP). The program is to replace approximately 16,000 old drayage trucks serving the Ports in phases before 2012 by instituting a concession program and providing grants from the Ports and the State. Key programs elements include implementing the Ports' Proposition 1B program, automatic vehicle locator (AVL), clean diesel engine compliance and retrofit, Drayage Truck Registry (DTR), grant processing and monitoring, concession development, administration and audits, and public outreach programs targeted to key stakeholders.

- **Technical Project Manager, Los Angeles World Airports, Phase III of the Los Angeles International Airport Air Quality Source Apportionment Study, (2011-Present):** Responsible for overall technical program design, implementation and management, including two seasonal field programs to measure ambient air quality and meteorological parameters, source profile study, fuel analysis, receptor modeling, nonparametric trajectory analysis, emission inventory and dispersion modeling to assess impacts of airport operational emissions to air quality of adjacent communities.

- **Technical Manager, New York City Department of Transportation, The Hunts Point Clean Trucks Program, (2011-onging):** Responsible for technical program design, database development, truck retrofit/replacement/scrappage program development, rebate application development, processing, technical evaluation, emission reduction estimation, price point analysis, cost-benefit analysis, and overall program implementation, enforcement and monitoring/reporting.

- **Technical Lead, Port Authority of New York and New Jersey, Regional Truck Emission Reduction Program, (2009-onging):** Responsible for technical program design, truck replacement/scrappage program development, grant application development, grant database development, processing, evaluation and monitoring/reporting.

- **Technical Leader, Technical Support to the Ports of Los Angeles and Long Beach – Low Sulfur Marine Fuel Availability Study, CA, Ports of Los Angeles and Long Beach, (2007 – ongoing):** Conducted low sulfur marine fuel availability study, including bunker supplier interview, survey data analysis and world refinery capacity assessment, determining low sulfur fuel availability to meet additional demands from implementing ocean-going vessel control measures (OGV-3 and OGV-4).

- **Technical Leader, Technical Services to the Port of Los Angeles for the Preparation of Greenhouse Gas Baseline Inventory, Los Angeles, CA, Port of Los Angeles, (2007 – 2008):** Prepared the Port of Los Angeles' 2006 greenhouse gas baseline inventory. The inventory was prepared according to the California Climate Action Registry (CCAR) general reporting protocol. Maintained and updated the inventory in 2008.

- **Lead Technical Expert, Technical Assistance to U.S. Trade Development Agency Sponsored Definitional Mission – North East China, Air Pollution Sector, U.S. Trade Development Agency, (2005):** Conducted a Definitional Mission project sponsored by U.S. Trade Development Agency to review, on-site interview, select and recommend candidate air pollution control related proposals for funding. A total of 22 proposals were reviewed and 8 candidate proposal sites were visited and interviewed to finalize the selection.

- **Task Manager, Program Management and Technical Support to Port of Los Angeles Clean Air Program, Los Angeles, CA, Port of Los Angeles, (2004 – ongoing):** Provided overall daily program management and technical support to Port of Los Angeles to manage and implement air emission abatement programs to reduce diesel particulate missions from major sources in the Port, including ocean-going vessels, harbor craft, cargo handling equipment, heavy duty trucks and locomotives. Developed a comprehensive program management database, which serves as an information management tool for daily management decision making, progress updates and tracking of emission reductions and finance information.

- **Lead Technical Expert, Feasibility Study of a Centralized Medical Waste Treatment Facility, Radioactive Wastes and Chemical/Hazardous Material Emergency Response System, Tianjin City, China, (2003 – 2004):** Provided technical support to the US-TDA sponsored feasibility assessment to determine requirements for a centralized treatment facility in Tianjin City, China to handle medical wastes, a storage and treatment facility to handle low-level radioactive wastes and, the development of an emergency response system for chemical and hazardous waste spill and accidental releases. Developed conceptual and implementation plan. Provided cost estimates and summary report.

- **Technical Leader, Southern Vandenberg Power Plant Continuous Emission Monitoring System Upgrade Project, Vandenberg Air Force Base, CA (2002 – 2004):** Provided technical support to conduct an opportunity assessment to determine the requirements for upgrading Southern Vandenberg Power Plant, Vandenberg Air Force Base, CA. Developed implementation plan and supervised equipment vendors to complete system integration and certified the upgraded system.

- **Air Quality Leader, Feasibility Study of Expanding and Upgrading Shanghai Environmental Monitoring Network – Air Quality, Shanghai, China, (2001 – 2002):** Provide technical support to the US-TDA sponsored air quality network inspection to determine requirements for expanding and upgrading Shanghai Environmental Monitoring Network. Developed conceptual and implementation plan. Provided cost estimates and summary report.

- **Technical Leader, Development of QA/QC Requirements for Taiwan Air Quality Monitoring Network, Taiwan (1999 – 2000):** Developed QA/QC requirements for the operation of Taiwan Air Quality Monitoring Network (TAQMN) including criteria pollutant monitoring, meteorological and acid deposition measurements. Developed a ranking system to rank local agency's monitoring stations and incorporated these stations into the National Air Quality Monitoring Network.

- **Air Quality Leader, Qingdao Air and Water Quality Management Program, Qingdao, China, (1998):** Provided technical support to the Swedish International Development Agency (SIDA) sponsored project to establish an air and water quality management information center in Qingdao City, China. Work provided included emission inventory preparation, technology transfer, seminars and report preparation.

- **Lead Consultant, Performance Evaluation of Vehicle Emission Testing Stations and Feasibility Study of an Inspection/Maintenance Program for Vehicle Emission Testing Taiwan, (1998):** Provided technical guidance and consultation to evaluate vehicle emission testing facility performance in support of island-wide remote sensing program. Conducted feasibility of establishing a vehicle emission Inspection / Maintenance (I/M) program in Taiwan area.

- **Lead Technical Expert, Air Emission Pollution Prevention Projects, Vandenberg Air Force Base, CA (1997 – 2004):** Conducted opportunity assessments to determine the requirements for reducing various air emissions at Vandenberg Air Force Base, CA, including stationary and mobile sources. Developed implementation plan and documented emission reductions achieved.

- **Program Manager, On-Road Vehicle Emission Measurement in Hong Kong by Remote Sensing, Hong Kong, China, (1997 – 1998):** Conducted on-road vehicle emission measurements in Hong Kong. Analyzed the data to understand emission distribution pattern, cut-point and scientific basis for control policy development.

- **Lead Technical Expert, On-Road Vehicle Emission Measurement in Taiwan by Remote Sensing, Taiwan, (1996 – 2001):** Conducted on-road vehicle emission measurements in Taiwan area. Analyzed the data to understand emission distribution pattern, cut point and scientific basis for control policy development. Developed high emitter profile model to facilitate the identification of potential high emission vehicles.

- **Lead Technical Expert, Implementation of Continuous Emission Monitoring Quality Assurance Audit Program for ROCEPA - Phase I - Pilot Study and Phase II, Steel, Cement and**

Utility Industries, (1995): Conducted quality assurance audits on stationary sources continuous emission monitoring (CEM) systems, including demonstration program as well as various industries CEM systems

- **Lead Researcher, Feasibility Study of Using a DOAS (Differential Optical Absorption Spectroscopy) as a Fenceline Monitor, ROCEPA, (1995):** Conducted a feasibility study of using DOAS - OPSIS open-path monitor for measuring organic pollutants from a petrochemical complex. The DOAS measured results were validation by whole air canister sampling followed by GC-MS analysis.

- **Lead Technical Expert, Development of Continuous Emission Monitoring Quality Assurance Specifications for ROC EPA, (1994):** Designed and developed quality control/quality assurance guidelines and specifications for stack continuous emission monitoring. Demonstrated RATA certification tests on several utility stacks. Provided technical assistance in public hearing and training to local agencies and industrial personnel.

- **Program Manager, Technical Assistance for Installation of ROC EPA Taiwan Air Quality Monitoring Network (TAQMN), (1993):** Conducted performance specification acceptance tests of TAQMN, consisting of 66 stations, 3 mobile monitoring vans, and a quality assurance laboratory, and environmental monitoring center computer data acquisition system. Assisted EPA personnel in technical meetings and discussions with the prime contractor for the installation.

- **Technical Leader, Development of Ambient Air Toxics, Particulate Lead and Noise Monitoring Programs, ROC EPA, (1992):** Developed ambient monitoring programs for air toxics, lead, and noise. Prepared detailed work plan as well as siting and quality assurance project plan (QAPP) for each monitoring program. Conducted training course to facilitate technology transfer of monitoring and quality assurance audit techniques.
- **Technical Leader, Development of Ambient Air Monitoring Station Siting Procedures, ROC EPA, (1992):** Developed regional-specific and population exposure oriented procedures for selecting ambient monitoring station sites. The procedures were developed based on local industrial emission types, meteorological characteristics, population distribution and housing patterns, and commuting patterns.

- **Technical Leader, Implementation of ROC EPA Air Quality Monitoring Quality Assurance/Quality Control (QA/QC) (II) - Measures to Ambient Air Quality Monitoring Stations, ROC EPA, (1992):** Conducted ambient air quality monitoring station quality assurance audits. Provided technical training of quality assurance principles, audit procedures, and techniques to ROC EPA and industry personnel.

- **Technical Leader, Development of ROC EPA Air Quality Monitoring QA/QC (I) - Design and Planning, Quality Assurance Management Plan (1991):** Developed framework for ambient air quality monitoring QA/QC program. Performed QA audits on 19 local stations. Provided technology transfer of QA/QC techniques. Developed agency-wide quality assurance management plan to incorporate all aspects of environmental monitoring programs.

- **Lead Air Quality consultant, Multiple-year Operation and Maintenance, Industrial Development Bureau, Ministry of Economic Affairs, ROC, (1991):** Provided technical assistance in QA/QC of environmental and safety monitoring networks for two industrial parks.

- **In-country Lead Auditor, Technical Assistance to AT&T/Lucent Technology China Facility Environmental, Health and Safety Audits (1990, 1993, 1996, 1999 and 2000):** Conducted Environmental, Health and Safety audits at AT&T/Lucent Technology manufacturing facilities in China and Taiwan according to the ISO 14000 and ISO 18000 guidelines and requirements.

- **Technical Leader, Design and Acceptance Test of a Plant-Wide Safety and Early Warning System, Chinese Petroleum Corporation, (1990 – 1992):** Designed a plant-wide safety and early warning system (SAEWS). The system included ambient air, plant fence-line, stack emission, plant process, bulk storage tank, meteorological and security monitoring. Supervised the selection of quality bidders for installation. Performed final acceptance tests to assure that installation adhered to original specifications.

- **R&D Laboratory Manager, Analytical Method Development for S(IV) Measurement in Precipitation Samples, U.S. EPA, (1998):** Developed and field tested sampling and analytical methods for the measurement of S(IV) species in wet/dry deposition samples collected in ACID-MODE study.

- **R&D Laboratory Manager, Measurement of Gas Phase Peroxides in the 1987 SCAQ Study, by Coordinated Research Council (CRC), (1987):** Developed and performed field collection procedures of gaseous phase peroxides in SCAQ study. Analyzed collected samples by peroxidase-fluorescence technique.

- **R&D Laboratory Manager, Development of Sampling and Analytical Methods for the Measurement of Carbonyl in the Atmosphere, (1987):** Developed two-dimensional gas chromatographic technique coupled with cryogenic trapping sampling technique to measure individual ambient carbonyl species and its concentrations.

- **R&D Laboratory Manager, Management of Analytical Research and Development Laboratory, (1985 – 1986):** Planned and started up an analytical research and development laboratory. Directed and managed laboratory staff to develop innovative analytical technologies to support non-routine analysis, such as the development of an automated canister air sampling and analysis apparatus to support off-shore platform air emission study. Performed remediation feasibility studies using pilot scale reactor to demonstrate the performance of various hazardous waste treatment technologies prior to full-scale field application.

- **Hazardous Waste Analytical Laboratory Manager, Start-up, Certification and Management of a Hazardous Waste Analytical Laboratory (1983 – 1984):** Planned and started up a hazardous waste analytical laboratory to provide analytical services for pollution identification and site remediation assessment projects. Completed State laboratory certification in three months after start-up and obtained annual renewal of certification. Managed laboratory staff and approved analytical reports.

Kent C. Johnson, Ph.D., CE-CERT

Associate Research Engineer, Emissions & Fuels Research

CE-CERT 022, University of California, Riverside, CA 92521-0434 kjohnson@cert.ucr.edu

Education

PhD. Chemical and Environmental Engineering, University of California, Riverside,	2009
M.S., Electrical Engineering Controls, California State University, Pomona,	2003
B.S., Mechanical Engineering, California State University, San Luis Obispo,	1992

Professional Experience

Over 15 years of research specifically related to the characterization and performance of diesel engines. Primary responsibility include emission related programs with annual budgets >$1,000,000. Main responsibilities include development, execution, and design of testing projects; the analysis and interpretation of test results; and the preparation of project specific data for reports and scientific articles. Projects include characterization of heavy duty Natural Gas vehicles with lean burn and three way catalysts systems; characterization and impact of 2010 compliant heavy-duty diesel vehicles and their impact on regional emissions; evaluation and characterization of heavy-duty hybrid evaluations and heavy duty electric vehicle evaluations.

2009 – Present	Assistant Research Engineer, Emissions and Fuel Research (EFR), University of California, Riverside (UCR) College of Engineering Research and Technology (CE-CERT
2008 – 2009	Principle Development Engineer, EFR, UCR – CE-CERT
2003 – 2008	Senior Development Engineer, EFR, UCR – CE-CERT
1998 – 2003	Associate Development Engineer, EFR, UCR – CE-CERT
1995 – 1998	Assistant Development Engineer, EFR, UCR – CE-CERT
1992 – 1995	Junior Development Engineer, EFR, UCR – CE-CERT
1990 – 1990	Engineer Intern, Contra Costa County Sanitation District
1989 – 1989	Engineer Intern Badische Stahl Werk (BSW) GmbH, Kehl, Germany
1988 – 1988	Surveyor, Delmar Fultz Civil Engineering

Relevant Technical Experience

- International Council on Clean Transportation (ICCT), Marine Black Carbon Emissions Testing, 8/15 – 12/16, $350,000.
- Coordinating Research Council, “Very Low PM Mass Measurement Phase 2: Evaluation of Partial Flow Dilution, E-99-2”,7/15 – 12/16, $522,078.
- CARB “Collection of Activity Data from On-Road Heavy-Duty Diesel Vehicles”, 10/13 – 10/15, $371,321
- CEC “Plug-in LNG Hybrid Heavy-duty Truck (PLHT)” $1,632,268 10/2011 – 10/2013
- SCAQMD “In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines”, 11/2/2011 – 12/01/2013, $708,534.
- ENVIRON International Corporation, Demonstration of Battery-Powered, Heavy-duty Truck, 6/1/2012 to 12/31/2012, $11,977

- California Air Resources Board (CARB), AB 118 Hybrid Incentive Demonstration and Evaluation Program AQIP, 7/1/2011 – 2013, $2,000,000
- Tetra Tech "Comparing Criteria and Greenhouse Gas Emissions from a Conventional Diesel and a Prototype Hybrid Yard Tractor, 2009 - 11/2010, $80,000
- CARB, "PM PEMS Measurement Allowance Program", 3/09-6/10, $650,000
- Miratech Corporation and SCAQMD, "Selective Catalytic Reduction combined Diesel Particulate Filter Efficiency and Durability Evaluation on a In-Use Metrolink Locomotive Auxiliary Engine", 3/08-12/09, $100,000

Synergistic Activities

- 2007 – Present Emissions Measurement and Testing Committee (EMTC) participant
- Member, Society of Automotive Engineers, American Society of Mechanical Engineers, and American Association for Aerosol Research
- Committee Member, Measurement Allowance Steering Committee
- Committee Member, Emissions Measurement and Technical Committee
- Organizer, International Portable Emissions Measurement System (PEMS) Workshop

Publications and Presentations

Tanfeng Cao, Robert L. Russell, Thomas D. Durbin, David R. Cocker III, Andrew Burnette, Joseph Calavita, Hector Maldonado and Kent C. Johnson, 2015, A Generalized Approach for Characterizing Emissions Benefits of Hybrid Off-Road Equipment via Physical Activity and Engine Work: A Case Study for Bulldozers, submitted 2016.

Tanfeng Cao, Thomas D. Durbin, David R. Cocker III, Roland Wanker, Thomas Schimpl, Volker Pointner, Karl Oberguggenberger, and Kent C. Johnson, 2015, A Comprehensive Evaluation of a Gaseous Portable Emissions Measurement System with a Mobile Reference Laboratory, Emissions Control Sci. & Technol, 2, 173-180.

Varalakshmi Jayaram, M Yusuf Khan, William A Welch, Kent Johnson, J. Wayne Miller, David R Cocker III (2015) A generalized approach for verifying the emissions benefit of off-road hybrid mobile sources Emiss. Control Sci. Technol. DOI 10.1007/s40825-015-0032-9, December 2015

M. Yusuf Khan, Kent C. Johnson*, Thomas D. Durbin, Heejung Jung, David R. Cocker III, Dipak Bishnu, Robert Giannelli, Characterization of PM-PEMS for In-Use Measurements Conducted during Validation Testing for the PM-PEMS Measurement Allowance Program, Atmospheric Environment 55 (2012) 311e318

Johnson, K.C., Durbin, T.D., Cocker D.R., Miller, W.J., Bishnu, D.K., Maldonaldo, H., Moynahan, N., Ensfield, C., Laroo, C.A., (2009) On-road Comparisons of a Portable Emissions Measurement System with a Mobile Reference Laboratory for a Heavy-Duty diesel Vehicle, Atm. Env. 43 (2009) 2877-2833, 2009.

A.A. Sawant, A. Nigam, J.W. Miller, K.C. Johnson, D.R. Cocker, ''Emissions From In-use Diesel-Electric Switching Locomotives,'' Environmental Science and Technology, 41, 17, 6074-6083, 2007.

D.R. Cocker, S.D. Shah, K.C. Johnson, J.W. Miller, J.M. Norbeck (2004) "Development and Application of a Mobile Laboratory for Measuring Emissions From Diesel Engines I. Regulated Gaseous Emissions" Environmental Science and Technology, 38, 7, 2182-2189, 2004.

Thomas D. Durbin, Ph.D., CE-CERT

Research Engineer, III

Bourns College of Engineering - Center for Environmental Research and Technology, University of California, Riverside

EDUCATION AND TRAINING:

Ph.D., University of California, Riverside, Physics, 1994

M.S., University of California, Riverside, Physics, 1989

B.S., University of California, Riverside, Physics, 1988 (with High Honors)

RESEARCH AND PROFESSIONAL EXPERIENCE:

Principal investigator for a variety of mobile source related programs with annual budgets of approximately >$1,000,000. Responsibilities include research and program development and management, proposals, project budgeting, the establishment and execution of project plans and schedules, daily oversight of project testing, the analysis and interpretation of test results, and the preparation of project reports and scientific articles.

- Research Engineer, Level I & II, (2009 – present)
    - Center for Environmental Research and Technology, University of California, Riverside
- Associate Research Engineer, Levels I-III, (2003 – 2009)
    - Center for Environmental Research and Technology, University of California, Riverside
- Assistant Research Engineer, Levels II-IV, (1996 – 2003)
    - Center for Environmental Research and Technology, University of California, Riverside
- Post Doctoral Researcher, (1994 – 1996)
    - Center for Environmental Research and Technology, University of California, Riverside
- Research Assistant, (1992 – 1993)
    - Center for Environmental Research and Technology, University of California, Riverside
    - Graduate Student Researcher, (1990 – 1994)
- Physics Department, University of California, Riverside
- Assistant Technical Staff Member, 1990, The Aerospace Corp., El Segundo, CA
- Technical Summer 1985 and 1988, Rockwell International, Lakewood and El Segundo, CA

Relevant Technical Experience

ERG-EPA, “PEMS - National Deployment of Portable Emissions & Activity Measurement Systems in Support of the Development & Improvement of Mobile Source Emission Factors”, 5/16 - 1/17, $106,582, PI.

ERG-EPA, “PEMS - National Deployment of Portable Emissions & Activity Measurement Systems in Support of the Development & Improvement of Mobile Source Emission Factors”, 10/1/2015 - 1/31/2016, $64,590, PI.

California Air Resources Board “Certification and In-Use Compliance Testing for Heavy-Duty Diesel Engines to Understand High In-Use NOx Emissions engine v chassis”, 9/15 – 8/17, $500,000, PI.

California Air Resources Board “Aerodynamic GHG Emissions Reduction Assessment of Non 53-foot Trailers Pulled by Heavy-Duty Tractors”, 6/15 – 6/17, $500,000, Co-PI.

CARB, “Evaluation of feasibility, cost-effectiveness, & necessity of Equipping Small Off-road Diesel Engines with Advanced PM and/or NOx aftertreatment,” 8/14-8/16, $800,000, PI.

California Energy Commission “Alternative Fuels/Mixed Alcohols Testing Program.” 7/10-1/14, $1,200,000, PI.

Synergistic Activities

Contributing Author IPCC 2006 Inventory for Greenhouse Gases

Third Alternate Member of the EPA's Federal Advisory Committee Act

Mobile Source Technical Review Subcommittee [MSTRC] (1999-2003)

Member of the EPA's OBDII policy workgroup [under the MSTRC] (1999-2003)

Member Society of Automotive Engineering

Event Captain 2002 Future Truck Competition

Publications and Presentations

Tanfeng Cao, Kent C. Johnson, Thomas D. Durbin, Robert L. Russell, David R. Cocker III, and Hector Maldonado, 2016, Evaluations of In-Use Emission Factors from Off-Road Construction Equipment, Atmos. Environ., 147, 234-245.

George Karavalakis, Daniel Short, Diep Vu, Robert Russell, Akua Asa-Awuku, Thomas Durbin. 2015. A complete assessment of the emissions performance of ethanol blends and iso-butanol blends from a fleet of nine PFI and GDI vehicles, SAE Technical Paper No. 2015-01-0957.

Daniel Short, Diep Vu, Thomas Durbin, Georgios Karavalakis, and Akua Asa-Awuku, 2015, Particle Speciation of Emissions from Iso-Butanol and Ethanol Blended Gasoline in Light-Duty Vehicles, J. Aerosol Sci., 84, 39-52.

Robert L. Russell, Kent Johnson, Thomas Durbin, Patrick P. Chen, Jasna Tomic, and Richard Parish. 2015. Emissions, Fuel Economy, and Performance of a Class 8 Conventional and Hybrid Truck, SAE Technical Paper No. 2015-01-1083.

Hajbabaei, M., Johnson, K.C., Okamoto, R., Mitchell, A., Pullman, M., Durbin, T.D., 2012. Evaluation of the Impacts of Biodiesel and Second Generation Biofuels on NO_x Emissions for CARB Diesel Fuels. Environmental Sci. Technol., 46, 9163-9173.

Robert R. Russell, Kent C. Johnson, Thomas D. Durbin, Nicole Davis, and Jim Lents. 2014. Regulated Emissions from Liquefied Petroleum Gas (LPG) Powered Vehicles. SAE Technical Paper No. 2014-01-1455, Presentation at the SAE 2014 World Congress & Exhibition. Detroit, MI, April.

Zheng, Z., Durbin, T.D., Johnson, K.C., Hu, S., Huai, T., Kittelson, D.B. and Jung, H.S., 2013. Comparison of particle mass (PM) and solid particle number emissions (SPN) from a heavy-duty diesel vehicle under on-road driving conditions and a standard testing cycle, Environ. Sci. Technol., 48, 1770-1786.

Kanok Boriboonsomsin, Ph.D., P.E., CE-CERT

Kanok Boriboonsomsin, Ph.D., P.E.

Education

2002 - 2004 Ph.D., Transportation Engineering, University of Mississippi

1999 - 2001 M.Eng., Infrastructure Engineering, Asian Institute of Technology, Thailand

1995 - 1999 B.Eng., Civil Engineering, Chulalongkorn University, Thailand

Professional Licensures

2008 - Present Professional Traffic Engineer, State of California

2008 - Present Professional Civil Engineer, State of Michigan

Post-Graduation Work Experience

2012 - present Associate Research Engineer, CE-CERT, University of California at Riverside

2012 - present Associate Adjunct Professor, Department of Chemical and Environmental Engineering, University of California at Riverside

2007 - 2012 Assistant Research Engineer, CE-CERT, University of California at Riverside

2005 - 2007 Postdoctoral Scholar, CE-CERT, University of California at Riverside

2004 - 2005 Visiting Assistant Professor, Department of Civil Engineering, Ohio Northern University

Areas of Expertise

Vehicle emissions modeling, vehicle activity analysis, transportation planning, intelligent transportation systems, traffic operations, traffic simulation, GIS applications in transportation

Professional Activities

- Member (2011-present) and Paper Review Co-chair (2012-2014), Transportation and Air Quality Standing Committee, Transportation Research Board
- Member, Institute of Transportation Engineers
- Associate Editor, *IEEE Intelligent Transportation Systems Magazine*
- Peer Reviewer for EPA's technical reports "Draft MOVES2009 highway vehicle population and activity data" and "Population and Activity of On-road Vehicles in MOVES2014"
- Member of Technical Advisory Committee for "High-Cube Warehouse Truck Trip Generation" study, National Association of Industrial and Office Properties, 2008-2011
- Member of Organizing Committee of 2010 IEEE Intelligent Vehicles Symposium

Selected Relevant Publications

- Boriboonsomsin, K., Johnson, K., Scora, G., Sandez, D., Vu, A. Durbin, T., Burnette, A., Yoon, S., Collins, J., Dai, Z., Fulper, C., Kishan, S., and Sabisch, M. (2017). "Idle activity patterns of heavy-duty vehicles in California." *27th CRC Real-World Vehicle Emissions Workshop*, Long Beach, CA, March 27-29.
- Boriboonsomsin, K., Johnson, K., Scora, G., Sandez, D., Vu, A. Durbin, T., Burnette, A., Yoon, S., Collins, J., Dai, Z., Fulper, C., Kishan, S., and Sabisch, M. (2017). "Engine soak and start activity patterns of heavy-duty vehicles in California." *27th CRC Real-World Vehicle Emissions Workshop*, Long Beach, CA, March 27-29.
- Boriboonsomsin, K., Johnson, K., Scora, G., Sandez, D., Vu, A. Durbin, T., Burnette, A., Yoon, S., Collins, J., Dai, Z., Fulper, C., Kishan, S., and Sabisch, M. (2017). "*Vocation-specific drive cycles of heavy-duty vehicles in California*." 27th CRC Real-World Vehicle Emissions Workshop, Long Beach, CA, March 27-29.
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- Boriboonsomsin, K., Scora, G., Karavalakis, G., Durbin, T., and Johnson, K. (2016). "Modeling emissions from light-duty vehicles traveling at high speeds in California." *26th CRC Real-World Vehicle Emissions Workshop*, Newport Beach, CA, March 14-16.
- Roth, P., Espinosa, C., Vu, D., Boriboonsomsin, K., Durbin, T., Asa-Awuku, A., and Karavalakis, G. (2016). "Particulate emissions from light-duty vehicles operating at low and high speeds representative for California highways." *26th CRC Real-World Vehicle Emissions Workshop, Newport Beach*, CA, March 14-16.
- Scora, G., Boriboonsomsin, K., Johnson, K., Yoon, S., and Jaw, K. (2016). "Vocation-specific activity patterns and temperature effects of on-road heavy-duty diesel vehicles in California." *6th International PEMS Conference*, Riverside, CA, March 17-18.
- Boriboonsomsin, K., Sheckler, R., and Barth, M. (2012). "Generating heavy-duty truck activity data inputs for MOVES based on large-scale truck telematics data." *Transportation Research Record*, 2270, 49-58.
- Boriboonsomsin, K., Scora, G., and Barth, M. (2010). "Analysis of heavy-duty diesel truck activity and fuel economy based on electronic control module data." *Transportation Research Record*, 2191, 23-33.
- Scora, G., Boriboonsomsin, K., and Barth, M. (2010). "Effects of operational variability on heavy-duty truck greenhouse gas emissions." *Proceedings of the 89th Annual Meeting of the Transportation Research Board*, Washington, DC, January 10-14.

Selected Other Publications

- Scora, G., Boriboonsomsin, K., and Barth, M. (2015). "Value of eco-friendly route choice for heavy-duty trucks." *Research in Transportation Economics*, 52, 3-14.
- Boriboonsomsin, K., Zhu, W., and Barth, M. (2011). "A statistical approach to estimating truck traffic speed and its application to emission inventory modeling." *Transportation Research Record*, 2233, 110-119.
- Boriboonsomsin, K. and Barth, M. (2009). "Impacts of road grade on fuel consumption and carbon dioxide emissions evidenced by use of advanced navigation systems." *Transportation Research Record*, 2139, 21-30.

- Boriboonsomsin, K., Barth, M., and Xu, H. (2009). Improvements to on-road mobile emissions modeling of freeways with high-occupancy vehicle facilities. *Transportation Research Record*, 2123, 109-118.
- Boriboonsomsin, K. and Barth, M. (2008). “Impacts of freeway high-occupancy vehicle lane configuration on vehicle emissions.” *Transportation Research Part D*, 13(2), 112-125.
- Barth, M. and Boriboonsomsin, K. (2008). “Real-world carbon dioxide impacts of traffic congestion.” *Transportation Research Record*, 2058, 163-171.
- Boriboonsomsin, K. and Barth, M. (2007). “Evaluating air quality benefits of freeway high occupancy vehicle lanes in Southern California.” *Transportation Research Record*, 2011, 137-147.

George A. Scora, Ph.D., CE-CERT

George A. Scora

Assistant Project Scientist, Transportation Systems Research

CE-CERT, University of California, Riverside, CA 92521-0434 gscora@cert.ucr.edu

Dr. Scora has over 15 years of experience working at UCR's College of Engineering Center for Environmental Research and Technology (CE-CERT) where he currently holds a position as Project Scientist for the Transportation Systems Research group. His areas of interest include vehicle emission modeling and transportation related air quality issues. He has been heavily involved in the development of UCR's Comprehensive Modal Emissions Model (CMEM) and has worked with the U.S. EPA's Office of Transportation and Air Quality in Ann Arbor Michigan on data analysis and the development of light-duty and heavy-duty vehicle emission factors for EPA's Motor Vehicle Emission Simulator (MOVES) model.

Education

PhD.	2012	Chemical and Environmental Engineering	University of California Riverside
M.S.	2007	Chemical and Environmental Engineering	University of California Riverside
B.S.	1996	Environmental Engineering	University of California Riverside

Post-Graduation Work Experience

1996 - Present UCR College of Engineering Center for Environmental Research and Technology,

Project Scientist, Development Engineer and student researcher

2009 - 2010 US EPA's Office of Transportation and Air Quality, Student service position

2005 - 2006 US EPA's Office of Transportation and Air Quality, Remote internship

1995 - 1996 UCR College of Engineering Center for Environmental Research and Technology

Student researcher

Interests

Transportation/emissions simulation, modeling and integration; vehicle activity analysis, emissions analysis and intelligent transportation systems

Academic Awards and Honors

- UCTC Fellowship, 2006-2007
- Transportation Research Board Pyke Johnson Award, 2006.

Selected Publications

- **Scora, G.**, Boriboonsomsin, K., Barth, M. (2015). Value of eco-friendly route choice for heavy-duty trucks. Research in Transportation Economics. Vol. 52: p3-14. Month of Publication Oct.
- **Scora, G.**, Boriboonsomsin, K., and Barth, M. (2013). "Eco-friendly navigation system development for heavy-duty trucks." *Proceedings of the 92nd Annual Meeting of the Transportation Research Board*, Washington, DC, January 13-17.
- **Scora, G.**; Morris, B.; Tran, C.; Barth, M.; Trivedi, M. (2011). "Real-time roadway emissions estimation using visual traffic measurements," *Integrated and Sustainable Transportation System (FISTS), 2011 IEEE Forum on* , vol., no., pp.40-47, June 29 2011-July 1 2011
- H. Liu, M. Barth, **G. Scora**, N. Davis and J. Lents, (2010). "Using Portable Emission Measurement Systems for Transportation Emission Studies", *Transportation Research Record* No 2158, 56-60.
- Boriboonsomsin, K., **Scora, G.**, and Barth, M. (2010). "Analysis of heavy-duty diesel truck activity and fuel economy based on electronic control module data." *Transportation Research Record*, 2191, 23-33.

- **Scora, G.**, Boriboonsomsin, K., and Barth, M. (2010). "Effects of operational variability on heavy-duty truck greenhouse gas emissions." *Proceedings of the 89th Annual Meeting of the Transportation Research Board*, Washington, DC, January 10-14.
- Barth, M., **Scora, G.**, and Younglove, T. (2004). "A Modal Emission Model for Heavy Duty Diesel Vehicles", *Transportation Research Record* No 1880*,* pp. 10 – 20, 2004.

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Chino Hills, CA 91709
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EDUCATION:

Degree	Year Conferred	University
Management & Leadership Classes	2002-2005	University of La Verne
Ph.D. in Engineering	1998	University of California, Irvine
M.S. in Mech. Eng.	1993	University of California, Irvine
B.S. in Mech. Eng. (cum laude)	1988	University of California, Irvine

SUMMARY:

- Technical leader with excellent communication skills and successful experience in engaging local, regional, state and federal stakeholders to implement aggressive strategies to synergistically improve air quality, reduce greenhouse gas emissions and enhance national energy security.
- Team-player with proven success in collaborating while maintaining mutually respectful relationships with internal staff as well as external stakeholders.
- Well-regarded and sought-after SCAQMD representative for technical input and agency perspective.

EXPERIENCE:

Apr 13 – present: Deputy Executive Officer. South Coast AQMD

Responsible for the Technology Advancement Office, Mobile Source Division, and Monitoring and Laboratory Analysis Division. Principal charges are to identify, evaluate and stimulate development and commercialization of clean air technologies, develop and coordinate mobile source regulations, and to conduct ambient monitoring, source testing and laboratory analysis.

Feb 08 – Apr 13: Assistant Deputy Executive Officer. South Coast AQMD

Serve as the principal technology and operational lead under the Chief Scientist for the Technology Advancement Office, comprised of the Incentives, Demonstrations, Best Available Control Technologies and Outreach Groups. The funding throughput for these groups totals over $100M annually. Major responsibilities include overseeing daily operations and approvals, representing the AQMD on all major technology initiatives, including zero emission goods movement and plug-in hybrid vehicles, and interfacing with Board members, media and other regional, state and federal stakeholders. Notable accomplishments include lead technical staff for securing reauthorization of the AQMD Clean Fuels (research and demonstrations) Program, Principal Investigator on $45M DOE American Reinvestment and Recovery Act project for plug-in electric work trucks, Principal Investigator on $4.2M DOE Zero Emissions Cargo Movement project, and lead staff on Regional Zero Emissions Freight Movement Collaborative with LAMTA, Ports, SCAG, CalTrans and GCCOG.

Mar 03 – Feb 08: Technology Demonstrations Manager. South Coast AQMD

Administered the Clean Fuels Program for the advancement of clean, alternative mobile and stationary technologies. Managed approximately $12M in awards annually, with 5 technical and 4 administrative staff. Responsible for the Clean Fuels Annual Report and Plan Update to State legislature. Co-managed Blueprint Rollout Team for California Hydrogen Highway Network Blueprint effort. Staff representative to California Fuel Cell Partnership, California Stationary Fuel Cell Collaborative, Plug-in Hybrid activities, CARB Research Evaluation Screening Committee, and Ports Technology Advancement Advisory Committee.

Jun 02 – Mar 03: Program Supervisor, Clean Fuels Program. South Coast AQMD.

Executed advanced technology projects under the Clean Fuels Program from concept to completion. Responsible for the stationary fuel cell projects and heavy duty natural gas engine projects with DOE/NREL, which resulted in commercialized clean products.

Feb 01 – Jun 02: Senior Research Engineer. GE–Energy and Environmental Research Corp.

Conducted and managed commercial, low NO_x technology implementation projects for utility boilers. Oversaw the scheduling, construction, and testing of the physical flow laboratory as well as enhancing laboratory capabilities. Certified in GE's Six Sigma quality program, led new product development for low-NOx burner and identified as a GE top performer in 2001.

Jul 98 – Jan 01: Senior Research Engineer. Advanced Power and Energy Program, UC Irvine.

Conducted and directed the research for the Industrial Burners Program, encompassing active control implementation, stability sensor development, low NO_x mechanism research, and catalytic piloting as applied to industrial burners on sub- and commercial scales. Other duties included proposal writing, maintaining the five Laboratory Web sites, and serving as representative to the American Flame Research Committee

Jul 90 – Jul 98: Graduate Researcher. UCI Combustion Laboratory

Conducted research on pollutant formation mechanisms in industrial burners, specifically by applying laser diagnostics and CFD modeling to a practical burner system. Experience with laser systems, emissions analyzers, and practical burner hardware. Familiarity with machining and welding.

Jul 88 – Jul 90: Engineer. Nuclear Rate Regulation, Southern California Edison

Provided support to San Onofre Nuclear Generating Stations by interpreting data and writing testimony for rate cases before the Public Utilities Commission such that capital expenditures could be collected in rates.

PROFESSIONAL ACTIVITIES:
Society of Automotive Engineers
American Society of Mechanical Engineers
Air and Waste Management Association
Combustion Institute/Western States Section (Secretary 2003-04)
Adjunct Lecturer at UC Irvine (2001-2003)
Engineer in Training (1987)

AWARDS:
Mechanical Engineering Department Fellowship, 1996
Department of Education Fellowship, 1995
Air and Waste Management Association Fellowship, 1992
Engineering Corporate Affiliates Fellowship, 1990
Golden Key National Honor Society, 1988
Tau Beta Pi, Engineering Honor Society, 1987

RECENT PRESESENTATIONS:

"The Need for Zero and Near-Zero Emission Goods Movement Technologies," SCAG General Assembly, April 25, 2014.

"Transforming Transportation: the Air Quality Need for Zero & Near-Zero Emission Technologies," National Academies of Science study on fuel consumption, July 31, 2013.

"Transforming Transportation: Southern California Challenges, Lessons-learned and National Implications," Transportation Research Board Executive Committee, June 20, 2013.

"Implementing the Vision of Clean Transportation and Energy Technologies," Transportation Research Board Annual Meeting, January 14, 2013. Joint presentation with P. Greenwald.

PUBLICATIONS:

D. Dunn-Rankin, M. Miyasato, and T. K. Pham, Introductory Chapter for *Lean Combustion: Fundamentals, Applications, and Prospects*, Elsevier. March 2007.

M. M. Miyasato, V. G. McDonell, G. S. Samuelsen, "Active Optimization of the Performance of a Gas-Turbine Combustor." *Combustion Science and Technology*, 2005.

R. M. Flores, M. M. Miyasato, V. G. McDonell, and G. S. Samuelsen, "Response of a Model Gas Turbine Combustor to Variation in Gaseous Fuel Composition." *Journal of Engineering for Gas Turbines and Power,* 2000.

T. N. Demayo, M. M. Miyasato and G. S. Samuelsen, "Hazardous Air Pollutant and Ozone Precursor Emissions from a Low-NO_x Natural Gas-Fired Industrial Burner." *Twenty-Seventh Symposium (International) on Combustion*, the Combustion Institute, 1998.

R. K. Cheng, D. T. Yegian, M. M. Miyasato, G. S. Samuelsen, C. E. Benson, R. Pellizzari, and P. Loftus,"Scaling and Development of Low-Swirl Burners for Low Emission Furnaces and Boilers." *Twenty-Seventh Symposium (International) on Combustion*, the Combustion Institute, 2000.

ACADEMIC CONFERENCE PAPERS:

M. M. Miyasato, R. M. Flores, V. G. McDonell, and G. S. Samuelsen, "Active Optimization of a Model Gas Turbine Combustor." *Western States Section/Combustion Institute 2000 Winter Meeting,* Golden, CO March 13-14, 2000.

M. M. Miyasato, V. G. McDonell, and G. S. Samuelsen, "Adaptive Fuel Injection Strategies For Industrial Combustion Sources." *Western States Section/Combustion Institute 1999 Fall Meeting*, Irvine, CA October 25-26, 1999.

M. M. Miyasato and G. S. Samuelsen, "Reaction Chemiluminescence and Its Relationship To Emissions and Stability in a Model Industrial Burner." *American Flame Research Committee International Symposium*, San Francisco, October 3-6, 1999.

M. M. Miyasato and G. S. Samuelsen, "Multivariate Optimization for NO_x and CO Emissions in a Model Industrial, Natural Gas Fired Burner." *American Flame Research Committee International Symposium*, Maui, Hawaii. October 1998.

M. M. Miyasato and G. S. Samuelsen, "Modeling and Velocity Measurements at the Burner Throat: The Relationship to Performance in a Model Industrial, Natural Gas Fired Burner." *American Flame Research Committee International Symposium*, Baltimore, Maryland. October 1996.

REFERENCES:

Available upon request

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OBJECTIVE: To work for a company where growth, commitment, and learning are essential to building a career in the field of Electrical Engineering.

EDUCATION

CALIFORNIA STATE UNIVERSITY, LOS ANGELES (2010 – 2012)
Master of Science, Electrical Engineering
- Emphasis in Power and Computer

CALIFORNIA STATE UNIVERSITY, LOS ANGELES (2004 – 2008)
Bachelor of Science, Electrical Engineering
- Emphasis in Communications and Electronics
- Classes in Power, Control, and Technology Taken

EXPERIENCE

Work

Los Angeles D.W.P. – New Business Metro West Service Planning (Jan 2014 – Current)

-Dedicated Commercial Electric Vehicle Service Planning Engineer
-Los Angeles World Airports Dedicated Service Planning Engineer
-Design Customer Commitment Plans for Private Property Construction by reviewing single line diagrams, load schedules, & site plans
-Review Customer's Single Line Diagram
-Create Construction Work Packages for Conduit and Cable Installation
-Review Customer Switchboard Designs for Approval/Purchase
-Support District/Customer on Construction
-Manage 50+ projects
-Customer Support
-Bill and Collect payments for Construction Projects

Los Angeles D.W.P. – New Engineer Associate Training (N.E.A.T) Program (Jan 2013 – Jan 2014)

-Centralized Training (Power System Engineering Process, Project Management, Construction, Commission Testing, Maintenance, Repair, etc.)
-Rotation (Design, Field, Planning & Development, Energy Control Center)

Southern California Edison – Substation Engr. – Added / Interconnection Facilities (June 2011 – Dec 2012)

-Project Management
-Substation Design and Drafting

Computer Repair Services – Computer / Network Consulting (2008 – 2010)

-IT Services / Telecommunications
-Network / Security: Design / Setup

CSULA - Student Assistant (2007 – 2008)

-Worked alongside Dean of Engineering for Club/Organization Development
-Major Events/Projects Coordination

Symmetry Electronics – Engineering Assistant (2006 – 2007)

-Assist E-Commerce Marketing / Field Application Engineers in Technical Knowledge
-Design and Map Electronic Equipment Using Product Lineup

Leadership

- Eta Kappa Nu Honor Society – President (2007-2008), Member (2005-2008)
- ECST Student Council – President (2007-2008), Treasurer (2006-2007)
- Institute for Electronics and Electrical Engineers (IEEE) – Vice President (2007-2008), Member (2004-2008)
- Society of Automotive Engineering – Public Relations Officer (2004-2008), Captain (2010-2011)
- Tau Beta Pi Honor Society – Member (2007-2008)

- Society of Hispanic Engineers and Science Students – Member (2004-2008)

Projects

- SAE Supermileage Project – President (2010-2012), Public Relations (2004-2008)
  - -Project Management for Mechanical/Civil/Electrical/Technology Disciplines
  - -Fuel Injection Unit – Electronics Design

Awards

- Martin S. Roden Scholarship – Academic Excellence and Advancement in the field of Electrical Engineering
- NACME Scholarship – Recognition of Leadership and Advancement in the field of Electrical Engineering
- LSAMP – Recognition of Academic Excellence in the field of Science and Engineering
- CSULA Honors – Recognition of Academic Achievement

ADDITIONAL INFORMATION

- Languages: English / Chinese (Mandarin and Cantonese) / Vietnamese
- Computer Proficiency: Word, Excel, Powerpoint, Matlab, C++, PSPICE, Photoshop, Autocad, Windows, Microstation, Microsoft Project, Work Management Information System (WMIS),
- Excellent Oral and Written Communication Skills

Jesse N. Marquez

1601 N. Wilmington Blvd., Ste. B, Wilmington, California 90744
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Jesse N. Marquez is the founder and Executive Director of the Coalition For A Safe Environment (www.cfasecares.org) for 16 years. The Coalition For A Safe Environment was established in April 2001 and is an Environmental Justice, Public Health and Public Safety advocacy organization involved in International Trade Ports, Goods Movement, Freight Transportation Corridors, Energy, Petroleum Industry and Wildlife Conservation issues. The Coalition is headquartered in Wilmington a community in the City of Los Angeles where the Port of Los Angeles is located, neighbor to the Port of Long Beach, the Alameda Corridor and home to four major oil refineries. The Coalition has over 500 members in over 25 cities in California.

Domestic & International Travel:

30+ US States, Canada, England, Germany, Netherlands, Russia, Colombia, Mexico

Governmental Agency Committees (Current & Past)**:**

Governor California Freight Advisory Committee
California Department of Toxic Substance Control - Environmental Justice Advisory Committee
Southern California Association of Governments - Goods Movement Advisory Committee
Los Angeles County Planning Dept. Environmental Justice Advisory Committee
California AB 32 Global Warming Environmental Justice Advisory Committee (Past)
METRANS Multi - County Goods Movement Advisory Committee (Past)
Gateway Cities Air Quality Plan Advisory Committee (Past)
City of Los Angeles & City of Long Beach - Ports Clean Air Action Plan Implementation Taskforce (Past)
South Coast Air Quality Management District (SCAQMD) - Refinery Pilot Project Working Group
South Coast Air Quality Management District - Air Quality Management Plan Advisory Committee (Past)
SCAQMD - Clean Port Air Monitoring Partnership (Past)
California Air Resources Board - Children's Environmental Risk Reduction Plan - Project (Past)
Governor's California State Goods Movement Plan - Cabinet Integrated Working Group (Past)
Port of Los Angeles - Port Community Advisory Committee (Past)

Organization Affiliations:

Los Angeles Environmental Justice Network	Member
California Communities Against Toxics	Member
Moving Forward Network	Member
California Clean Freight Coalition	Member
Green L.A. - Port Working Group & Cumulative Impact Working Group	Member
Coalition For Clean & Safe Ports	Member
Trade, Health & Environment (THE) Impact Project	Member
Environmental Justice Network of Southern California	Member
Californian's for Renewable Energy (Past)	Member
Ratepayers for Affordable Clean Energy (Past)	Member
Environmental Justice Water Coalition (Past)	Member
Modesta Avila Coalition (Past)	Member
California Environmental Rights Alliance (Past)	Board Member
Harbor Community Benefit Foundation (Past)	Board Member

Nature & Wildlife Organizations

Sierra Club - Harbor Vision Taskforce	Member

Palos Verdes/South Bay Audubon Society (Conservation Award Recipient)	Member
Burrowing Owl Conservation Network	Member
Center for Biological Diversity	Member

Expertise:

Public Policy:	Environmental Justice, Public Health, Public Safety, Sustainability, Social Equity
Environment Regulation:	Federal Clean Air Act, Federal Clean Water Act, NEPA, CEQA, AB32, UN IMO MARPOL Annex VI, MOTEMS
Air Quality:	Federal, State & SCAQMD Standards, Rules, Regulations, Testing, Analysis, Monitoring, Reporting, Equipment
International Trade Ports:	Green Port Facilities Design/Operation, Logistically Efficient Freight Transportation, Logistically Efficient Import Car/Vehicle, Chassis, Container Storage.
Petroleum Industries	Oil, Gas Drilling, Refining, Storage & Distribution Regulations, Carbon Sequestration
Public Health:	Health Impacts Assessments (HIA), Health Risk Assessments (HRA), Public Health Surveys
Research:	Community Based Participatory Research (CBPR) - Public Health, Air Quality, Water Quality, Land Quality, Wildlife Habitat Quality
Zero/Near Zero Emissions Technologies	Truck, Train, Cargo Handling Equipment, Ship
Emissions Capture & Treatment Technologies	Ship, Train, Truck, Cargo Handling Equipment, Petroleum Industry Vapor Recovery Systems

Publications (Partial List)**:**

Importing Harm: U.S. Ports' Impacts on Health and Communities
THE Impact Project Policy Brief Series   January 2012

Driving Harm: Health and Community Impacts of Living Near Truck Corridors
THE Impact Project Policy Brief Series   January 2012

THE (Trade, Health, Environment) Impact Project: A Community-Based Participatory Research Environmental Justice Case Study, Environmental Justice, Vol. 6, No. 1, 2013

Trade-Health- Environment: Making the Case for Change and Paying With Our Health-The Real Cost of Freight Transport in California   June 2009

Paying With Our Health: The Real Cost of Freight Transport in California   November 2006

Former Employment:

20 years experience in the consumer, industrial and military electronics manufacturing industry.
Positions held included: Test Technician, Test Lab Manager, Production Supervisor, Production Manager, Auditor Specialist, Manufacturing Engineer and Quality Engineer.

Hobbies:

Photography/Videography	30 Years Professional Photography, 10 Years Videography, Photo/Video Editing
Archaeology	Aztec History & Culture
Rare Map Collecting	American Southwest Maps
Chicano/Native American	Book & Art Collecting

“POLA Zero-Emission Track Miles Locomotive Demonstration” Clarifying Questions - POLA

Questions

1. On page 4 of the application’s Project Narrative and Work Plan, it is stated that the proposed project would build upon an existing TAP project, titled “Near-Zero Emissions Locomotive Demonstration Project,” and the proposed project and the existing project would not interfere with each other. The scoring team would like to know the current status of this existing demonstration, when the existing demonstration is planned to be completed, and more details regarding how the applicant will ensure that the two projects can both operate simultaneously without interfering with each other.

Answers

The current Technology Advancement Program (TAP) project is still in development. As you know, the TAP project is a near-zero locomotive engine, where natural gas engines would power an electric motor that would serve as the primary drive system for the locomotive. Note that most locomotive engines have electric drive systems, where under normal circumstances diesel engines run a generator that in turn powers the electric motor. In this case, those diesel engines are being replaced with near-zero natural gas engines (referred to as natural gas generators) to power the electric motor. Importantly, in addition to the natural gas generators, this locomotive also includes large backup diesel generators, whose only purpose would be to power the locomotive under emergency situations.

All components of the near-zero power system are either delivered or in final stages of development. The main electric motor has been completed for a few months. The natural gas generators are currently in the process of being mounted on the main electric motor. The backup diesel generators have not yet been delivered. Final construction of the near-zero locomotive is scheduled to be completed in the second quarter of 2018. Demonstration of the TAP project is scheduled to occur for at least 3000 hours of operation (approximately 1 year of service) as required by CARB for emissions verification so as to verify the emissions at near-zero.

The new zero emission track mile proposal that has been submitted for your consideration would replace the backup diesel generators with a series of battery packs. In this case, neither the battery packs nor the natural gas generators are designed to serve as backup systems. Instead, the locomotive is set up to test both systems independently, where either the natural gas generators or the battery packs could be selected to power the electric motor. This would not be a hybrid set-up, as either system would need to be selected manually. This locomotive would be essentially two power systems on one platform. The battery packs are anticipated to provide power for approximately 8 to 9.5 hours of consistent operation, and will take a significant time to recharge. In order to test both the near-zero and zero emission systems, the locomotive will operate on a two phase cycle. The first phase will operate on battery power until the batteries are depleted. The second phase will operate on natural gas generators for approximately two days giving the locomotive the chance to recharge the battery packs during the downtime at night. Once the battery packs have fully recharged the two phase cycle will begin again. This proposed work plan allows for both the TAP project and the new proposal to occur simultaneously and independently.

Follow-Up Questions

1. In your application, it is stated that the CNG portion of the locomotive will 'only be used during shifts that exceed the zero-emission track-miles capability of the demonstration locomotive' and that the batteries will supply enough energy for one full shift with a recharge time of 12 hours. In your answers to CARB's clarifying questions, it appears as though the batteries will be run for one shift and then the CNG will be used for two full days afterwards. It would appear as though the CNG portion will be used a lot more than claimed in your initial application. Could you please clarify this point and provide more details as to why the CNG portion of the project will be utilized for atleast 2/3 of the time of operation. In addition, could you provide more details regarding the normal operation of this switcher locomotive? As an example, does it operate for one 8-12 hour shift and then rest for the remaining 12-16 hours? Finally, the quantification methodology assumed the demonstration would operate 100% on electricity. Is this assumption still valid for the demonstration?

Follow-Up Answers

In your application, it is stated that the CNG portion of the locomotive will 'only be used during shifts that exceed the zero-emission track-miles capability of the demonstration locomotive' and that the batteries will supply enough energy for one full shift with a recharge time of 12 hours. In your answers to CARB's clarifying questions, it appears as though the batteries will be run for one shift and then the CNG will be used for two full days afterwards. It would appear as though the CNG portion will be used a lot more than claimed in your initial application. Could you please clarify this point and provide more details as to why the CNG portion of the project will be utilized for at least 2/3 of the time of operation.

We appreciate the opportunity to further clarify our proposed work plan. We are excited about the potential of our proposal because of the unique opportunities that are presented by adding zero emission (ZE) battery packs onto the same platform as our planned near-zero emission (NZE) CNG locomotive demonstration. Both the ZE and NZE systems will be tested in parallel, allowing for a literal side-by-side comparison of the viability of each advanced technology. Additionally, the resulting data set will be available to assist in future design considerations, allowing for accurate projections of the final commercial configuration of the locomotive, including analysis of a potential hybrid configuration with zero emission mile capabilities in the future. Finally, under our proposed work plan both technologies will undergo sufficient testing to certify their respective emissions levels, allowing for the quickest potential path to future widespread commercialization across the state of California.

In our original clarification on November 2, 2017, we indicated that the locomotive would run in ZE mode for one shift and then the CNG mode would be used for approximately two days afterwards. A more detailed statement of the proposed operation is for the ZE operation rate to be approximately 43%. (See bullet 3 for the detailed explanation of this rate.) The rationale behind offering this plan, rather than a simple calendar-based demonstration period required in the solicitation, is to allow the locomotive to be CARB verified in both near-zero emissions (NZE) and ZE mode by the end of the TAP and CARB demonstrations as follows:

1) Under the current TAP funded demonstration program, the locomotive needs to run in NZE CNG mode to fulfill CARB's requirements for a 3,000-hour test in order to satisfy CARB verification requirements.

   POLA understands that this 3,000-hour demonstration and emissions testing is primarily to verify that significant emissions degradation does not occur to the locomotive that would reduce the expected low emissions target. Degradation of the emissions system of an internal combustion engine (ICE) or its after treatment systems is a real threat to actual locomotive emissions, hence CARB's requirement of long-term in-use testing.

2) Since a battery locomotive is not expected to experience any emissions degradation of its "power source" (i.e. the locomotive battery system), we are proposing a nine-month demonstration that will include a minimum of 1,000-hours battery operation, which will be run in parallel with the existing NZE locomotive project. We believe the proposed 1,000 hours of heavy operation in zero-emissions mode on a railroad like PHL will be sufficient time to show the railroads that the battery system is indeed capable of sustained and constant switcher locomotive operation and would thus be marketable as a zero-emission battery powered switcher locomotive for use by all railroads in California.

   Additionally, if CARB agrees that 1,000 hours is sufficient for CARB verification, the ZE system would be available for immediate sale throughout California, which would minimize delay from this demonstration to full commercialization of a zero-emission battery powered switcher locomotive for California in 2019.

3) Since PHL operates their locomotives for about 3,125 hours per year, POLA's project team plans to operate the battery locomotive technology every three out of seven shifts. At an average of 8.5[1] hours per shift for the nine-month battery

[1] Actual shifts average from 8.5 to 12 hours; the in-use operation is designed to exceed a minimum of 8.5 hours of ZE operation, but the demonstration will teach us how much further the design can achieve. For ease of calculation, the minimum hours of ZE operation (8.5 hours per shift) were used to characterize the demonstration's operational modes.

locomotive demonstration, the locomotive would operate in 100% zero-emissions electric mode for 117 days (the equivalent of nearly four months of consecutive ZE operation). This works out to the locomotive running on 100% battery power for **43%** of the nine-month demonstration period based on a weekly operations schedule of:

Day 1 on battery
Day 2 on CNG
Day 3 on battery
Days 4 and 5 on CNG
Day 6 on battery
Day 7 on CNG

The cycle then repeats itself. Over the nine-month demonstration, the locomotive would accumulate 1,000 hours of battery operation to potentially meet CARB ZE battery locomotive verification (assuming CARB accepts a 1,000 hour verification proposal for ZE battery locomotives), and 1,344 hours of CNG running toward the 3,000 hours of CARB verification needed for an internal combustion engine powered locomotive.

4) After the proposed CARB ZE technology demonstration concludes, during the final three months of the currently scheduled TAP program 1-year demonstration the locomotive would operate exclusively in NZE CNG mode. This will result in approximately 2,100 hours of near-zero CNG operation in the first year of operation. In order to complete the 3,000-hour CARB demonstration for verification, the locomotive will continue to operate in CNG mode for an extended 3-4 month period beyond the currently scheduled TAP CNG demonstration period. This extension would be acceptable to the project team if POLA is selected for the CARB grant to support evaluation of zero-emission battery operation. This is the basis for our statement in our proposal that the zero-emission battery locomotive demonstration would not interfere with the current near-zero emissions CNG locomotive demonstration. Thus, during the nine-month demonstration period for the ZE project, CARB would collect sufficient data to demonstrate the technical viability of a zero-emission battery locomotive, the railroads would have sufficient operational data to make the same conclusion, and, following the completion of the full CNG project, the locomotive will have completed the 3000 hours of CNG operation required for CARB verification of the NZE system as well as the 1,000 hours for a ZE battery system verification.

5) Since POLA's nine-month parallel demonstration of both ZE and NZE technologies will be carried out on the same locomotive platform, direct comparisons are possible of the operational capabilities of the ZE battery locomotive and the NZE CNG locomotive. The same single locomotive will operate in the exact same areas, operational venues, duty cycles, and shifts, eliminating important operational variables. POLA believes this would be a

huge win-win for the adoption of both zero-emission and near-zero emissions locomotives, as this project offers an opportunity to gather a level of data and testing for a zero-emission battery locomotive that could otherwise take several years to fully develop. Additionally, this data could be used to design a potential hybrid configuration of both systems.

In addition, could you provide more details regarding the normal operation of this switcher locomotive. As an example, does it operate for one 8-12 hour shift and then rest for the remaining 12-16 hours?

Yes, this is correct. As noted above, the current PHL locomotive fleet operates for about 3,125 hours per year. This *averages* out to 8.5 hours per day, 365 days per year. The remainder of the time the locomotives are not in use, so this time can be used to recharge the batteries.

Finally, the quantification methodology assumed the demonstration would operate 100% on electricity. Is this assumption still valid for the demonstration?

Yes, and no, depending on the intent of the question.

<u>Yes</u>, because during the shifts that the locomotive operates as a zero-emission battery locomotive, it will operate 100% on electricity. The NZE CNG engines will only be used for a shift that was assigned to ZE operation, if the locomotive runs out of battery power before the end of the shift. As mentioned in our application, the battery system has been sized so as to provide for a full shift of operation in a standard EPA switcher locomotive duty cycle. Hence, the goal is that the locomotive will not need to move to NZE CNG operation at all during most PHL zero emission shifts; the exact results will depend on number of trains the locomotive is assigned to during a day, train tonnage, number of switching moves required, and distance the train must be moved, and are a critical output of the proposed demonstration.

<u>No</u>, if you are referring to the last column in the table at the top of Page 14 of the Application (Section 6 – Potential Emission Reduction Benefits). Although this column was not required as part of the application, we included it to provide better context to our project as a whole. However, in order to reflect the actual 1000 hours of zero-emission demonstration, instead of 2,343 hours[2] of full-time locomotive operation over a nine month period initially provided, we have included the updated column in the table shown below.

Please note that our base quantification methodology follows all guidance in CARB's Appendix D: Methodology for Determining Emission Reductions and Cost-Effectiveness. Key directions in this methodology are (1) to utilize a Tier 4 baseline emissions profile, and (2) utilize the baseline equipment activity, in our case, 3,125 hours per year for the GHG and criteria pollutant emission calculations; these results are summarized in Column B, matching the results presented in Attachment 3 of the application. Column C was added to reflect the per-unit benefits of this

[2] 3,125 hours/year * 9 months / 12 months per year = 2,343 hours per 9 months.

project if the ZE technology were to replace the balance of equipment in PHL's fleet of Tier 3 diesel locomotives. Column D simply applied a ratio of 9/12 (9 months out of one year) to Column C results. Column E provides the actual reductions, which are based on 1,000 demonstration hours.

A	B	C	D	E
Pollutant (per ARB Methodology in Appendix D)	**Annual Reductions (tons/yr) from Tier 4 Baseline (Att. 3)**	**Annual Reductions (tons/yr) from Tier 3 Baseline, reflective of PHL fleet**	**Actual Reductions (tons/yr) during 9-month demo, vs. T3 (2,343 hours)**	**Actual Reductions (tons/yr) during 9-month demo, vs. T3 (1,000 hours)**
GHG (in metric tons CO2e)	462.31	462.31	346.73	147.94
NOx (tons)	0.888	3.421	2.565	1.095
ROG (tons)	0.109	0.459	0.344	0.147
PM10 (tons)	0.019	0.063	0.047	0.0200
Weighted Emission Redux	1.377	5.131	3.848	1.642

The emission reduction potential of the technology, which was calculated based on CARB's Appendix D methodology and based on our understanding of the guidance document, does not change as a result of these clarifications. Only the estimated benefits of the nine-month demonstration should be scaled back based on the actual 1,000 hours of zero emission operation.

POLA Answers to Further Clarification Questions **2-05-2018**

CARB Question #1: It is stated in your application that, during demonstration, the technology will alternate between CNG and electric mode on a day to day basis even if operating fully electric could be feasible. CARB would be interested in testing whether it is feasible to operate the switcher in all-electric mode continuously for an extended period of time without switching between CNG and electric. Therefore, would it be possible to operate the switcher in fully electric mode for consecutive periods of time (possibly entire weeks of all electric mode) during the demonstration? This would involve running the switcher as fully electric, charging the batteries during down times, and then continuing to run fully electric after charging without switching to CNG usage unless necessary. Also, if this is possible to accomplish during the demonstration, please set forth a possible schedule which includes duration and operational conditions or cycles which would occur during this type of demonstration.

We appreciate the opportunity to further revise our proposed work plan. As stated in our response to the initial clarifying questions on November 4th, 2017, we are excited about the potential of our proposal because of the unique opportunities that are presented by adding zero emission (ZE) battery packs onto the same platform as our planned near-zero emission (NZE) CNG locomotive demonstration. However, the focus of this project is primarily on the demonstration of the battery system as if it were fully ZE locomotive. Thus, at least some portion of the demonstration should ideally include several days wherein the locomotive operates completely as a ZE locomotive. POLA and VeRail are proposing to operate the locomotive on a five-week cycle. The first 28 days or four weeks of the demonstration period would be run on a weekly basis as described below:

Day 1 on battery
Day 2 on CNG
Day 3 on battery
Days 4 and 5 on CNG
Day 6 on battery
Day 7 on CNG

To specifically accommodate ARB's suggestion above, the 5th week would be run entirely on batteries. As a result, the start of the next five-week cycle would begin on CNG for two straight days and then return to the regular schedule. The five-week cycle will then repeat itself over the nine-month demonstration. The final two weeks of the entire nine-month demonstration will be run on entirely on batteries. To provide clarification, the attached spreadsheet shows the entire nine-month schedule in detail both on a daily and weekly basis.

The locomotive under this plan is scheduled to accumulate 1,144 hours of battery operation to potentially meet CARB ZE battery locomotive verification (assuming CARB accepts a 1,000 hour verification proposal for ZE battery locomotives), and 1,151 hours of CNG running toward the 3,000 hours of CARB verification needed for an internal combustion engine powered locomotive.

After the proposed CARB ZE technology demonstration concludes the locomotive is planned to operate exclusively in NZE CNG mode for 3 more months or until it reaches 3000 required hours for ARB certification.

CARB Question #2: The solicitation requests on page 28 that the applicant "Describe how the funded project equipment will be used and the expected dispositions of the funded project equipment and infrastructure after the end of the term of the grant agreement." Please provide this information.

VeRail will own the locomotive and battery system at the end of the demonstration. Should PHL wish to purchase the locomotive following the full demonstration, the battery system will be included at no extra charge. That is to say, PHL will be charged the normal price of VeRail's NG VR21C4-nz locomotive (the official designation of VeRail's CNG locomotive). As part of the sale to PHL, VeRail intends to incorporate mechanisms to allow for additional potential buyers to view the locomotive in operation, including limited duration evaluations at other railroad locations. If PHL does not purchase the locomotive, VeRail plans to maintain the locomotive at a location in California for further demonstration with railroads in California interested in evaluating the VeRail locomotive for purchase.