Guidance Document for Approval of Zero-Emission Switcher Locomotives

California Air Resources Board
Transportation and Toxics Division
Freight Technology Advancement Branch
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Introduction

The California Air Resources Board (CARB) staff has developed a voluntary evaluation and approval procedure for zero-emission switcher locomotives. CARB is aware of the growing interest in zero-emission technologies for switcher locomotives and is providing transparent performance, warranty, and other criteria that manufacturers, operators, and others may choose to use or build upon.

This Guidance Document provides guidance to switcher locomotive manufacturers voluntarily applying for CARB approval for a zero-emission switcher locomotive or a zero-emission switcher conversion system for existing locomotives. It outlines the scope and applicability of this approval process, the types of eligible products, the approval criteria and other information required to be provided by manufacturers seeking approval through this process, and details of how to apply.

General Information

1. Who can apply for CARB approval of a zero-emission switcher locomotive or zero-emission switcher conversion system for existing locomotives?

This process is for manufacturers of zero-emission switcher locomotives or zero-emission switcher conversion systems for existing locomotives to apply to receive CARB approval for a specific model or family of models. In this guideline and application form, "applicant" or "manufacturer" means any person or entity who manufactures a zero-emission locomotive or zero-emission conversion system for existing locomotives intended for sale, lease, or operation in California. The applicant is responsible for ensuring the accuracy of the information provided in the application.

2. What products and technologies do these approval criteria and process apply to?

This approval process applies to commercial-ready new-build switcher locomotives as well as switcher conversion systems for replacing the engine in existing locomotives with a zero-emission drivetrain.

This approval process is applicable only to locomotives with zero exhaust emissions including any criteria pollutants or greenhouse gases. Eligible zero-emission technology may include, but is not limited to, battery-electric or hydrogen fuel-cell technology.

3. What does CARB consider a switcher locomotive for the purpose of this guideline?

Switcher locomotives are locomotives that have the primary function of performing applications such as moving railcars in and around railyards and helping to assemble trains. A switcher locomotive is defined in Title 40, Code of Federal Regulations (CFR) Part 1033 (Control of Emissions from Locomotives) as a locomotive powered by an engine with a maximum rated power (or a combination of engines having a total rated power) of 2,300 horsepower (hp) or less. This approval process is applicable to zero-emission switcher locomotives aligning with this definition, including small locomotives (e.g. military and industrial). This approval process does not apply to railcar movers or any other vehicles with tires or mounted tracks, or otherwise equipped such that they can be used off of stationary rails or tracks. While these guidelines are geared towards CARB approval of switcher locomotives, CARB may consider commercial-ready locomotives above 2,300 hp on a case-by-case basis. The applicant is solely responsible for ensuring that manufacture, remanufacture, and operation of their switcher locomotive or conversion system complies with applicable federal, state, and local government requirements.

4. What qualifies as a "commercial-ready" locomotive or conversion system?

For the purposes of this approval process, a commercial-ready switcher locomotive or zero-emission conversion system for existing locomotives is one that has gone through sufficient testing and demonstration to ensure that it is reliable and effective in its intended application. The manufacturer must have at least one unit that has demonstrated the ability

to perform as stated in the application, and it must be considered ready to be sold/leased and deployed in railyards for normal use by operators. As stated in the approval criteria, the applicant shall provide a description of how the switcher locomotive or zero-emission conversion system has demonstrated its commercial readiness.

5. **Is approval required to be able to sell switcher locomotives in California?**

No. This approval process is intended to provide information to switcher locomotive customers and operators for the purpose of transparency. Other programs may choose to incorporate this process, but any such incorporation is at the discretion of those operating such programs. This CARB approval process is entirely voluntary and imposes no requirements on the sale of locomotives in California or elsewhere.

6. **Does approval guarantee funding of the applicable switcher locomotive through an incentive funding program?**

No. CARB is not guaranteeing any funding through this approval process. If funding programs opt to refer to this approval program in their guidelines or requirements, any requirement to obtain approval and any funding would result from decisions made by those operating such funding programs.

7. **Is this a verification process?**

No - this is an approval process. To further clarify, CARB's verification program provides a way to thoroughly evaluate the particulate matter (PM) and oxides of nitrogen (NOx) emission reduction capabilities and durability of a variety of diesel emission control strategies as part of a retrofit in-use program. It ensures that emission reductions achieved by a control strategy are both real and durable and that production units in the field are achieving emission reductions which are consistent with their verification. See the *Verification Procedure, Warranty and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines* (Verification Procedure) that was created and adopted by CARB on May 16, 2002. Verification of a NOx and/or PM control system under that Verification Procedure results in issuance of an Executive Order.

Zero-emission technology is not covered under the Verification Procedure. While this approval process does involve a similar evaluation of technology, it is not a verification process. Approval of a zero-emission locomotive or conversion system under this process results in issuance of an approval letter.

Application and Approval Procedures

1. Can multiple models or variants under the same family designation be submitted in one application?

If a switcher locomotive or zero-emission conversion system has multiple, but substantially similar, battery-pack and/or fuel-cell energy storage capacity options, these may be submitted as part of the same application. For example, a model with different battery-pack size-options may be included on one application if all battery packs share the same architecture, management strategies, and thermal controls. If a manufacturer has a family of models they wish to group for submission for approval, please contact staff to discuss before preparing the application and/or submitting.

A manufacturer's zero-emission switcher approval application must specify the differences between models within the family for each metric and information requirement, as applicable. For example, if the energy storage capacity varies between models in the same family, the application should specify what the value (or range of values) is for each model.

2. What is the process for applying for approval?

Before submitting a formal application, potential applicants are encouraged to contact CARB at ZESwitcherApprovals@arb.ca.gov to receive feedback regarding the eligibility and applicability of this approval process to a particular product.

To apply, a locomotive manufacturer must complete and submit the application form located on the *Locomotive Emission Verification and Technology Demonstrations* website. All sections of the form must be completed for the application to be considered for approval. Provide requested information as a numerical value or range of values as applicable.

3. Is there a cost to apply?

There is no cost to apply at this time.

4. What happens after my application is received by CARB?

The application will be reviewed by CARB staff and a determination of approval will be made. If approval is granted, CARB will issue a letter of approval to the applicant. As part of the application review and approval process, CARB may require that a manufacturer's commercial-ready switcher locomotive or zero-emission conversion system be made available for inspection.

5. What does CARB's review and approval process entail?

CARB's review and approval process consists of 3 major steps: Preliminary Review, Engineering and Compliance Review, and Final Approval Determination. These steps are described below, along with expected timelines. Note that the given timelines are approximate, and exact timelines will depend on the quality and completeness of the application.

Before submitting a formal application, prospective applicants are encouraged to contact CARB to discuss details of the application, receive feedback, and resolve any questions.

I. Preliminary Review: Within approximately 30 to 60 days of receiving the application, CARB will notify the applicant that the application has been received and whether the information submitted is sufficient to proceed to a full detailed review. It is expected that an application will be complete at the time of initial submission. If the application is not sufficient to proceed to a full detailed review, CARB shall request any missing information from the applicant. If, after requesting the missing information three times, CARB staff determines that the application is still not complete, the application will be terminated.

II. Engineering and Compliance Review: When the application is determined to be sufficiently complete, CARB staff will conduct a detailed engineering and compliance review to determine whether the application is adequate to support the approval process. If the application is missing technical information or is not adequate to support the approval process, CARB shall request additional information from the applicant. If, after requesting the missing information three times, CARB staff determines that the application is still not complete, the application will be terminated.

III. Final Approval: Following the Engineering and Compliance Review and upon determining that the application is satisfactory, CARB shall issue the letter of approval within approximately 45 to 60 business days.

If at any point during the review process an applicant's application is terminated, and the applicant wishes to attempt the approval process again, the applicant must wait at least 30 calendar days before submitting a new, revised application.

6. Can approval be revoked?

CARB reserves the right to modify, revoke, or suspend an approval if inaccurate or misleading information is provided as part of the approval application, or if CARB determines that an applicant does not fulfill the conditions of the application or continue to meet eligibility criteria.

7. How long does approval last? What happens when there are design modifications to an approved zero-emission switcher locomotive or zero-emission conversion system?

Approval of a specific switcher locomotive or zero-emission conversion system does not expire, but design modifications require evaluation, and may result in loss of approval status.

If an applicant modifies the design of an approved zero-emission switcher locomotive or zero-emission conversion system, the applicant must provide a detailed description of the design modification along with an explanation of how the modification will affect the operation and performance of the locomotive or conversion system. To support its claims,

the applicant may be required to submit additional test data, engineering justification and analysis, or any other information deemed necessary by CARB staff to address the differences between the modified and original designs. A design modification includes, but is not limited to any change of materials, specifications, or supplier of the parts of the zero-emission powertrain or related critical components (e.g. the energy storage system, hydrogen fuel cell system, hydrogen storage system, inverter, motors, energy, or thermal management systems, etc.) and software changes. Any modifications that do not significantly impact the original approved design, materials, and specifications including minor design upgrades or model updates may be reviewed and approved by CARB without the need for additional testing. However, the final decision rests solely with CARB.

8. Will any proprietary information shared in this process remain confidential?

CARB staff understands that some information required as part of this program's application process may include proprietary trade secrets or other confidential information and is committed to keeping such information confidential. CARB's vehicle and engine verification and certification programs have a proven track record of keeping such information confidential. If you wish to designate any information submitted as part of this application process as confidential information, please note the following:

> CARB's regulations in Title 17, California Code of Regulations, sections 91000 to 91022, and the California Public Records Act (Gov. Code §§ 6250 et seq.), address submission of public comments and confidential information. Information provided to CARB may be released (1) to the public upon request, except trade secrets that are not emissions data or other information that is exempt from disclosure or the disclosure of which is prohibited by law; and (2) to the Federal Environmental Protection Agency (EPA), which protects trade secrets as provided in section 114(c) (of the Clean Air Act and amendments thereto (42 U.S.C. §§ 7401 et seq.) and in federal regulation (Cal. Code of Regs., tit. 17, § 91010) and (3) to other public agencies provided that those agencies preserve the protections afforded to information that is identified as a trade secret, or otherwise exempt from disclosure by law (Health & Saf. Code, § 39660, subl(e)(2)).
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> Trade secrets as defined in Government Code section 6254.7 are not public records and, therefore, will not be released to the public. However, the California Public Records Act provides that air pollution emission data are always public records, even if the data falls within the definition of trade secrets (Gov. Code § 6254.7(e)). On the other hand, the information used in calculating emission information may be considered a trade secret (Gov. Code § 6254.7(e)).
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> If any company believes that any of the information it may provide is a trade secret or otherwise exempt from disclosure under any other provision of law, it must specifically identify the confidential information as such at the time of submission to CARB and must provide the name, address, and telephone number of the individual to be contacted if CARB receives a request for disclosure or seeks to disclose the data claimed to be confidential (Cal. Code of Regs, tit. 17, § 91011). CARB may ask the

company to provide documentation of its claim of trade secret or exemption at a later date. Data identified as confidential will not be disclosed unless CARB determines, in accordance with the above referenced regulations, that the records do not qualify for a legal exemption from disclosure. Note that general claims of confidentiality without identifying the specific confidential data may result in the information being released as a public record.

Approval Criteria / Information Provided by Manufacturer

This section provides additional information about the requirements included in the Application for CARB approval of zero-emission switcher locomotives and zero-emission switcher conversion systems for existing locomotives.

I. Application Section 1: Basic Locomotive Information

A. Third-Party Installer of Zero-Emission Conversion Systems

The manufacturer must have a written contractual relationship with its zero-emission conversion system installer(s). The zero-emission conversion system manufacturer must provide its authorized installer(s) with specific, written instructions and training regarding installation procedures for its conversion system. A copy of said written contract with its authorized installer(s) must be provided by the manufacturer to CARB upon request.

B. Requirement to Provide Manuals

The manufacturer must provide to the switcher locomotive purchaser/lessee owner's and service/repair manuals. These manuals are to be provided to CARB at the time of application. If a complete manual is not available at the time of application, exceptions may be considered on a case-by-case basis, provided that:

i. The complete manual will be available to the purchaser/lessee at the time of delivery of the switcher locomotive or zero-emission conversion system;
ii. At the time of application, the applicant submits to CARB a near complete draft of the manual, or a complete outline of the manual's contents and baseline or sample content as available;
iii. The applicant agrees to provide a copy of the entire manual to CARB upon its completion.

The owner's manual should contain at least the following information:

i. A brief description of the switcher locomotive or zero-emission conversion system, including major components and their principle of operation and proper operating procedures;
i. Charging and/or fueling procedures and protocols, as applicable;
ii. Maintenance best practices and a listing of necessary service and service intervals;
iii. Information about how to obtain manufacturer-authorized service and repair, including warranty repair. If mobile repair service is provided by the manufacturer in addition to or in lieu of physical service locations, the manufacturer shall provide a description of the services that can be performed in the field along with generally expected response times;
iv. All information necessary for the proper and safe operation of the switcher locomotive or zero-emission conversion system, including information on the safe handling of the battery or fuel cell system, favorable and unfavorable

operating conditions, and emergency procedures to follow in the event of leakage or other malfunctions that may affect the safety of the vehicle operator or emergency personnel;

v. The product warranty statement required pursuant to Section (III) of this Guidance Document;

vi. If a manufacturer provides or offers remote/wireless diagnostic and repair services, the applicability and limitations of this service type shall be clearly described.

The service manual should contain at least the following information:

i. How to obtain triggered fault codes, and how to interpret them;

ii. How to remove and install serviceable components;

iii. Schematics of the electrical, mechanical, and thermal management systems;

iv. Inspection and maintenance requirements, service intervals, procedures, and record-keeping requirements as applicable;

v. Safety considerations and precautions associated with included procedures.

II. Application Section 4: Performance Metrics

A. Testing Requirements

The applicant must demonstrate switcher locomotive performance through physical testing of a production locomotive or a production-representative prototype unit. For zero-emission conversion systems, the system must be installed on a locomotive that meets the parameters specified by the applicant in Part III Section 1 of the application.

i. Starting Tractive Effort

Perform Starting Tractive Effort standard test as follows. Alternately, provide detailed test methodology along with the remaining information requested in the test report described below.

a. Conduct test on a dry, recently traversed rail.
b. Connect battery-electric locomotive with another two load locomotives.
c. Measure the tractive effort and record through a data logger.
d. Put the two load locomotives in dynamic braking slow speed plug mode.
e. Move the notch handle from idle to N8 on the battery-electric locomotive.
f. Test at speeds from 2-5 miles per hour (mph).

The applicant is to submit a test report containing:

a. Specifications of the test locomotive as noted in Part III Section 1 of the application.
b. Details of the test methodology or indicate that a standard test was performed as described.

c. Test results including incomplete and aborted tests with sufficient descriptions.
d. For multiple models under the same family, describe how the locomotive used for testing may differ from the range of other locomotive models in the family, and explain how these differences might affect the test results.
e. For zero-emission conversion systems, describe how the locomotive used for testing may differ from the range of other locomotives that are compatible with the zero-emission conversion system, and explain how these differences might affect the test results.

ii. Charge time between defined percentages of battery state of charge, refueling time between hydrogen storage levels, or equivalent metric for other technologies.

The applicant is to submit a test report containing:

a. Specifications of the test locomotive as noted in Part III Section 1 of the application.
b. Details of test methodology, including defined percentages of state of charge or hydrogen storage levels.
c. Test results including incomplete and aborted tests with sufficient descriptions.
d. If results are anticipated to differ for multiple models under the same family, report the test results for each model tested, and report estimated results for the remaining models along with the good engineering judgement analysis used to obtain the estimates.
e. For zero-emission conversion systems, describe how the locomotive used for testing may differ from other locomotives that are compatible with the zero-emission conversion system, and explain how this might affect the test results.

iii. Durability Demonstration

The applicant must demonstrate the durability of the zero-emission locomotive or conversion system through a field demonstration of 1500 hours. In some cases, CARB may allow the applicant to conduct the durability demonstration in a simulation environment. For this to be considered, the applicant must provide a justification explaining how the test environment adequately simulates real-world conditions such as varying duty cycles and operating environment variables such as temperature, moisture, vibration, and shock.

To fulfil the requirements of the durability demonstration, the applicant must provide:

a. Data showing that the system is performing as expected, including measurements of performance indicators at intervals throughout the demonstration period. This should include, as applicable, energy storage system indicators such as operational status of batteries, temperature, output voltage, state of charge, and state of health.
b. Records of maintenance, service, and repairs performed during the demonstration period.
c. Details of any unexpected events or conditions that occurred during the demonstration period. For each event or condition, at a minimum, the following questions should be addressed:
    a. Whether the event or condition impaired function
    b. How function was impaired (if applicable)
    c. Whether repair was required
    d. Details of repair (if required), including:
        i. How event or condition was detected, and whether it triggered warnings or alarms before failure
        ii. Parts replaced
        iii. Time needed to resolve condition
        iv. Whether a manufacturer representative (e.g. factory-trained technician or engineer) would be required for a locomotive operator to resolve a similar condition
d. Statement from locomotive operator or qualified third-party test observer describing how the system performed during the durability demonstration, including corroboration of any unexpected events or conditions.

B. Other Performance Metrics

i. Power for Traction

Provide the power available for traction, excluding power consumed by systems not directly related to traction.

ii. Nameplate Energy or Fuel Storage

Provide the battery or fuel storage capacity:
a. Total onboard capacity
b. Capacity of individual battery cells or storage tanks, as applicable

iii. Usable Capacity

Provide the usable capacity as a percent of the nameplate energy storage (total onboard capacity). Specify whether the usable limit can be modified by the operator, and if so, whether it can be adjusted by the operator during locomotive operation, or only when the locomotive is offline/not in operation.

iv. Estimated Operation Time Per Charge

Estimated operation time per charge can be expressed as energy throughput per charge for the usable range, and the total operating time this would translate to for an expected duty cycle. This should be based upon the manufacturer's experience with the locomotive over a standard U.S. EPA switcher locomotive duty cycle, or an alternative duty cycle reviewed and approved by CARB. The applicant shall provide a brief narrative describing the duty cycle and operating condition assumptions that accompany this operating time estimate.

III. Application Section 7: Warranty Requirements

A. Minimum Warranty Coverage

The minimum warranty coverage required to receive CARB approval is 3 years with all parts of the entire locomotive and labor covered during the warranty period. Other programs, such as an incentive program, may have longer minimum warranty provisions.

B. Warranty Reporting

For each approved model or family, the applicant must submit a warranty report to CARB annually by April 1 of each calendar year. This reporting requirement is not limited to the minimum warranty period provided by the manufacturer and should be complied with for the duration of the approval's validity. The warranty report must include the following information:

1. The manufacturer's business name, number of California sales and leases for the given calendar year and the number of cumulative California sales and leases of the approved product. The locomotive sales/leases to be reported either had to physically occur in the state of California, or the locomotive sold/leased must be primarily intended for use in California.
2. The California production volume for the current and prior calendar year, and the cumulative California production volume of the approved product (across all calendar years);
3. A summary of California warranty claims for the approved product for existing locomotives in the current and prior calendar year. The summary must include:
    a. A description of the nature of the claims and of the warranty replacements or repairs provided. The applicant must categorize warranty claims by the part(s) and component(s) replaced or repaired;
    b. The number and percentage of zero-emission switcher locomotive or conversion systems for which a need for a warranty replacement or repair was identified;

c. A short description of the part and/or component that was replaced or repaired under warranty and the most likely cause for its failure;
d. For each part and/or component replaced or repaired under warranty, the number of annual and cumulative replacements or repairs of each part or component;
e. Name, physical business address, business e-mail address and business phone number of the end-user that filed the warranty claim and, if applicable, the company name. If personal, not business, information is given, the applicant must identify it as such;
f. The date each warranty claim was filed; and
g. A list of denied warranty claims and justification for each claim.

C. Extended Downtime Report.

For failures of warranted parts during the warranty period that prevent the CARB-approved zero-emission switcher from operating as per the manufacturer's specifications and that require the equipment to be out of service for more than 30 business days for repair (or multiple individual repairs that cumulate to 30 business days) in any six-month period, the manufacturer must:

1. Notify CARB upon reaching the 30 business day threshold;
2. Prepare and submit an Extended Downtime Report (EDR) to CARB within 30 business days following the completion of the repair.

An EDR requires the following:

1. Name and contact information of purchaser;
2. Description of equipment;
3. An explanation of the cause of the failure(s);
4. An explanation of delay(s) in repair;
5. Method(s) of repair;
6. How much time was needed to complete the repair(s) (including the time for equipment tear down, part(s) allocation, repair, and reassembly); and
7. Explanation of any necessary revisions to the manufacturer's service and-repair protocols (e.g., user training, part modification, etc.).