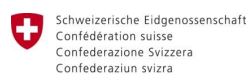


METHODOLOGICAL GUIDE



GUIDE FOR SELECTING THE MACHINERY FLEET FOR RETROFIT



Agencia Suiza para el Desarrollo
y la Cooperación COSUDE



CALAC+ is an SDC programme implemented by Swisscontact

Guide for selecting the machinery fleet for retrofit

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TECSUP headquarters in Lima, Peru; AVESCO Langenthal Switzerland (below); Skid-steer loader on public roads in Lima, Peru (above)

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The Climate and Clean Air project in Latin American Cities Plus (CALAC+) pursues a vision of healthier cities that seek to reduce their emissions of pollutants and greenhouse gases (GHGs) by encouraging a shift to soot-free, low-carbon city buses and non-road mobile machinery.

This guide is part of a series of 7 technical documents developed by CALAC+ to promote knowledge and environmental management of machinery emissions reduction in Latin America. The topics covered include the generation of inventories, estimation of pollutants, emission control systems, regulatory standards policies and monitoring of measures adopted.

The *Guide for selecting the machinery fleet for retrofit* develops the selection procedure based on technical, economic, protocol compliance and machinery use criteria.

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1. INTRODUCTION

The use of a high efficiency DPF system for diesel emissions aftertreatment has the potential to immediately reduce particulate emissions from both on-road and off-road fleets. However, the particulate filter does not replace the lack of engine maintenance; on the contrary, it requires properly maintained engines, as per manufacturer's requirements. This is because a faulty engine can lead to malfunction of the filter and even damage it irreparably..

Consequently, having an adequate maintenance and inspection programme is a step prior to or at least parallel to retrofitting as it allows emissions to be reduced so that the fleet can comply with technical and regulatory requirements.

It is therefore always necessary to properly select the fleet before retrofitting. This selection must meet the following criteria:

- The fleet must comply with the minimum technical conditions for the correct operation of the DPF system. In this regard, retrofitting must be carried out in a fleet previously maintained as per the engine manufacturer's specifications.
- The selected fleet must be able to timely comply with these technical conditions, by means of preventive maintenance protocols applicable during filter operation.
- Prior to retrofitting and during filter operation, a periodic inspection should be carried out to ensure that the fleet and filter are properly maintained.
- Retrofitting must be technically and economically feasible, in accordance with the technical conditions of the fleet, its activity and average lifetime.

This guide develops the procedure for selecting the fleet for retrofitting based on these criteria.

2. SELECTION OF THE FLEET FOR RETROFIT

This section introduces the general aspects involved in selecting the fleet for retrofitting.

Criteria:

- a. There are basically two options for prioritizing and selecting fleets for retrofit:
 - First, the authority defines the fleet, the goals and the schedule (deadlines) of the retrofit program, based on its own experience and fleet information.
 - Second, the authority defines only the retrofitting target (e.g. number of vehicles or machinery retrofitted or the fleet percentage or the emissions target) and its completion deadline, and the operating companies are responsible for choosing the most appropriate fleet to meet the target, based on technical and economic feasibility. In this case priorities are set by the company which seeks to technically and financially maximize its investment.
- b. Economic barriers may be present when selecting the fleet for retrofitting. For example, due to the age of the bus (short remaining lifetime) and low remaining economic value of the existing bus.
- c. A technical and business precondition for retrofitting is proper maintenance of the bus engine. Maintenance is a prerequisite for the correct operation of the DPF and the success of the program.

Measurements:

- a. Particulate filter retrofit should focus first on engines that are in relatively good condition, are well maintained, have high performance (in terms of their activity per year) and have sufficient remaining lifetime.
- b. In the case of fleet selected by the authority, such authority will apply the selection criteria above, based on the best available information. If the authority is only responsible for setting targets and deadlines, then it will be up to the operating company depending on the particular conditions of its fleet.

3. MAINTENANCE OF THE FLEET FOR RETROFIT

The effect that certain engine failures have on the DPF system (such as excessive soot or engine oil consumption, or injection system or turbo failure) is explained in the "GOOD PRACTICE GUIDE ON THE USE OF DPF SYSTEMS IN MACHINERY CONSTRUCTION" and is applicable to both on- and off-road engines.

Therefore, compliance with an appropriate maintenance program is critical for a successful retrofit program, both before and after DPF installation. Another benefit of good maintenance is the reduction of avoidable emissions, which can be substantial, for the entire fleet and not just for retrofitted engines.

Criteria:

- c. The particulate filter is not a substitute or a solution to the lack of maintenance of diesel engines, rather it requires engines to be maintained as per the manufacturer's requirements.
- d. Along with a retrofit program, an engine maintenance program must be in place or implemented for the entire regulated fleet in order to achieve and sustain the maximum possible emissions reduction over time, in accordance with the emission standard for the engine.
- e. As a result of the above, the operating company must have a regular and permanent preventive maintenance program, as per the engine manufacturer's recommendations, whether the fleet is retrofitted or not.
- f. Proper maintenance will allow the particulate filters to perform adequately; therefore, a fleet eligible for retrofitting should already have such a maintenance program in place or should implement one before the filters are installed.
- g. In the case of retrofitted engines, the DPF should also be maintained according to a regular and permanent preventive maintenance program, as per the DPF manufacturer's recommendations.

Measurements:

- a. The fleet eligible for retrofitting must have a preventive maintenance program in place as per the engine manufacturers' recommendations or one must be implemented for the fleet retrofit. The fleet operator is responsible for designing and implementing such a program.
- b. In any case, before installing the filters, the fleet engines must have an operating condition in accordance with the "GOOD PRACTICE GUIDE ON THE USE OF DPF SYSTEMS IN CONSTRUCTION MACHINERY ", regarding engine maintenance, lubricant consumption and exhaust gas opacity.
- c. After retrofitting, the DPF should be considered as part of the preventive maintenance program, as specified by the DPF manufacturer and in the "GOOD PRACTICE GUIDE ON THE USE OF DPF SYSTEMS IN CONSTRUCTION MACHINERY" and should comply with visual and exhaust gas verification, monitoring of datalogger, lubricant and fuel quality, and periodic cleaning of the DPF.
- d. The operating company should perform exhaust gas verification at least every six months, as part of a self-diagnosis.
- e. The result of this periodic "self-diagnostic" measurement must be carried on the vehicle or machinery. The authority defines the measurement method and the limit value to be met, separately for buses with and without DPF.

4. INSPECTION OF THE FLEET FOR RETROFIT

This inspection corresponds to the visual and instrumental verification of engine maintenance and other minimum conditions of the fleet for retrofitting. A third party should be responsible for independently ensuring compliance with the minimum parameters required. Although all the requirements for correct engine maintenance are necessary and must be guaranteed, only a few are within the scope of a quick and non-invasive inspection, namely the following:

a. Operator Identification

<ul style="list-style-type: none"> • Operator's data: 	<p>The following must be checked:</p> <ul style="list-style-type: none"> - Identification of the operating company. - Contact details (name, phone numbers, e-mail)
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b. Vehicle Identification

<ul style="list-style-type: none"> • Vehicle: 	<p>The following must be checked:</p> <ul style="list-style-type: none"> - Type (Backhoe, Bulldozer, Motor Grader, etc.). - Unique Identification Number (License Number, Patent, VIN or Chassis Number) - Manufacturer/Model. - Year of manufacture. - Mileage/Horometer.
<ul style="list-style-type: none"> • Engine: 	<p>The following must be checked:</p> <ul style="list-style-type: none"> - Manufacturer/Model. - Engine number. - Rated power. - Emissions standard (Stage I, Stage II, etc.) - Last maintenance (date and description).

c. Verify pollutant emission values as per manufacturer's specifications

<ul style="list-style-type: none"> • Opacity: 	<p>The following must be checked:</p> <ul style="list-style-type: none"> - Make/model of the opacimeter (a partial flow opacimeter with a measuring chamber length of 430 mm must be used, which meets the ISO 11614 specifications). - The opacity during free acceleration at the tailpipe - Conditions: <ul style="list-style-type: none"> o <i>Shift lever in the neutral position</i> o <i>Engine under normal operating conditions (water and oil temperature)</i> o <i>Measurement during free acceleration (perform two clean accelerations, no measurement, and then average the maximum value of 4 consecutive measurements)</i> - Criteria: <ul style="list-style-type: none"> o <i>The opacity of the exhaust gas before the filter must be as specified by the authority.</i>
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d. Check the exhaust system for fitting and leaks.

<ul style="list-style-type: none"> • Exhaust system fitting and mounting 	<p>The following must be checked:</p> <ul style="list-style-type: none"> - Visual check of the exhaust system to ensure there are no gaps or damage to the fitting or mounting. - Criteria: <ul style="list-style-type: none"> o No gaps or damage to the fitting/mounting
<ul style="list-style-type: none"> • Exhaust system leaks 	<p>The following must be checked:</p> <ul style="list-style-type: none"> - Visual check for exhaust gas leaks or soot in the joints before the filter. - Criteria: <ul style="list-style-type: none"> o There are no visible leaks.

5. PROGRAM IMPLEMENTATION

Criteria

- a. Conducting a retrofit pilot test prior to implementing the programme allows both the authority and the operators to draw on experience about the challenges involved.
- b. As a first step, an efficient maintenance and inspection system should be in place. Implementation should be gradual, i.e. start with a number of vehicles or machinery that is not too challenging and capitalize on the experience before moving on to the mass implementation program.

Measures

- a. Carry out a pilot test, together with the operators, with 7 to 14 vehicles or machines and capitalize on the experience.
- b. Establish an effective vehicle/machinery maintenance and inspection system.
- c. Establish a gradual implementation schedule.

6. CONCLUSIONS

- a. Particulate filter retrofit should focus first on engines that are well maintained, are in good mechanical condition, have high performance (in terms of their activity per year) and have sufficient remaining lifetime.
- b. The operator must have a regular and permanent preventive maintenance program, as per the engine manufacturer's guidelines, whether the fleet is retrofitted or not.
- c. Prior to and following retrofitting, a visual and instrumental inspection of the engine maintenance and other minimum conditions must be carried out every six months. A third party should be responsible for independently ensuring that the minimum required parameters are met.
- d. Prior to retrofitting, a pilot test will be carried out before the programme is implemented, allowing both the authority and the operating company to capitalise on experience regarding the challenges involved.
- e. Only after the above requirements have been met can implementation proceed gradually, i.e. start with a number of vehicles or machinery that is not too challenging and capitalize on the experience before moving on to the mass implementation program.



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