CANADA EMISSIONS REDUCTION INNOVATION NETWORK (CERIN) PUBLIC REPORT

1. PROJECT INFORMATION:

Project Title:	Methane Emissions in Stationary Engine Exhaust and Best Management Practices for Mitigation
Emissions Reduction Scope/Description:	Understanding of unburned methane emissions form stationary natural gas engine exhaust (known as methane slip)
Applicant (Organization):	Accurata
Project Completion Date:	Fall 2023

2. EXECUTIVE SUMMARY:

Methane slip from stationary natural gas engines is not well understood. Stationary natural gas engines are widely used in oil and gas production and electricity generation. New regulations by Environment and Climate Change Canada are being considered to limit methane slip. Field tests are required to define both the quantity of methane slip and what dictates the volume that is produced. A discussion of the current theory will be provided along with analysis of the emissions from 110 field tests to validate the behavior of these engines and what they emit. A discussion of the technology available will be developed along with best management practices.

3. KEY WORDS

Key words: stationary natural gas engine exhaust emissions, methane slip, best management practices

Natural Resources Canada | Ressources Naturelles Canada

Canada

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

ALBERTA INNOVATES

4. APPLICANT INFORMATION:

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6. PROJECT PARTNERS

Natural Resources Canada / Ressources Naturelles Canada

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Accurata Inc wishes to acknowledge the participation of PTAC, AUPRF, CRIN and our team of ASK Engine consulting, Spartan Controls and Signet Monitoring and Analysis.

A. INTRODUCTION

Sector

Stationary natural gas engines are widely used in oil and gas production and electricity generation.

Project Description:

Stationary natural gas engines are used throughout the oil and gas industry to drive field compression and power generation in gas plants as well as to power pumping equipment at some sites. These engines are known to produce some emissions of methane due to incomplete combustion in the engine, known as "methane slip". These emissions are not well understood as identified in past literature. This study involves a discussion of the current theory on methane slip and is further funded by AUPRF/CRIN for field tests on a wide range of engines. The completed project will provide testing and analysis of emissions from 110 field tests on up to 22 different engines. This will eventually allow for comparison to Original Equipment Manufacturers (OEM) data on methane slip and evaluation of potential causes of increased methane slip which may be better managed by operators in the future.

B. METHODOLOGY

Engine manufacturers all publish data that is obtained in their test stands. The data is legitimate but the test conditions cannot be reproduced in the field under normal operating conditions. Therefore, it is imperative to obtain operating data under field conditions.

Project team selected 22 engines and 5 examples of each model to provide 110 field tests. These engine models are representative of the most common manufacturers and models of lean burn and stoichiometric air fuel ratio engines.

Success of the field data collection program is dependent on the engine management system and the engine condition. The following characteristics are required for the test sample in order to allow the best chance for success:

1. The engines are driving reciprocating compressors so that we can readily estimate the engine loads with performance tests in the field.

2. The engine condition can be verified to be adequate.

3. The test engines must be equipped with the specified engine management system.

4. The engines are equipped with sensing points on the exhaust lines at the appropriate locations.

5. The engine crankcase vents may be readily disconnected and routed through a temporary sampling apparatus for the duration of the test.

Each system is different and selection of each unit with the different technologies must be carefully performed to ensure the sample of that specific technology is representative. Evaluation of the units selected for the test program is included. The various engine models have evolved over the years with improvements and upgrades. It is imperative that each engine model used in the study can be duplicated by others in their group.

Spartan Controls and Signet are to provide the data acquisition and analysis for the field test data. Their CEMS (Continuous Engine Monitoring System) trailer will be fitted with an oxygen sensor to perform each field test. Signet will perform the tests. An exhaust sample will also be collected and analyzed in the lab to compare with the field data collection. Some exhaust gas elements in the field measurement devices are calculated rather than measured.

Project team will summarize the data collected and determine the contribution of the unburned methane associated with the various engine management systems. They will identify the variance across engines for test results with respect to engine condition and operating variables. The emissions factors will be estimated based on the field test data along with sensitivity to the operating conditions.

Finally, aerial survey data may be made available by the work of others. The aerial data must be obtained at the same time and date as the field test is performed. If aerial test data is provided, then data analysis and reporting between aerial survey and field test results will be undertaken.

Theory and data analysis are provided by SME's. Signet Monitoring and Analysis will conduct the field tests on the engines using CEMS equipment and prepare the individual reports. SME's will gather and review the data to determine trends and relevant factors that affect methane slip. Conclusions will be presented on the behavior of methane slip and the factors that affect it.

C. PROJECT RESULTS AND KEY LEARNINGS

One of the outcomes of minimizing “methane slip” is to ensure that the maximum amount of natural gas fuel entering the engine is turned into drive energy through combustion. The initial portion of this project, funded through CanEric, provided information on the mechanisms of slip, (assessment of) results of other studies which looked at emissions and management practices and helped plan for the start of field testing of actual slip in a range of field engines to compare to manufacturers data. The behavior of methane slip and the factors that affect it will be analyzed. Regulations governing the allowable methane slip may be developed or modified based on project findings. This CERIN Template Report only briefly introduces the CanERIC portion of the project with initial effective project work occurring January to March, 2023.

Post CanERIC funding which ended March, 2023, this project will utilize funding from AUPRF/CRIN to enable further field testing and analysis from the first run tested in February 2023 through to the end of 2023. The focus is on assessing methane “slip” from natural gas engines which are used widely in the upstream oil and gas industry for compression and power generation. Field tests were completed at ~22 of the planned 110 field tests by the end of March 2023 on a number of engine models in a variety of installations with an ultimate goal of 5 samples of each engine model by the end of the project.

CanEric funding provided for the development of the field testing plan, research on testing methods and potential management practices to detect and reduce methane slip. Results from each run will be subjected to extensive analysis to determine the likely root cause of the emissions from each engine based on four main potential sources and will be compared to OEM data on expected emissions which are being assembled. Data from a large number of individual tests is required to draw any conclusions so no interim analysis is available until after the AUPRF/CRIN funded testing is completed later in 2023.

The report as part of the CanEric scope evaluated the impact of engine operations on nine key areas:

1. Emissions components (mainly CO_2, CO, NO_x, and CH_4);
2. Relationships between engine management systems and exhaust components for unburned methane contribution.
3. Engine management systems and design aspects that determine the behavior of the combustion process.
4. Crankcase blowby
5. Ingestive and non-ingestive systems for crankcase emissions.
6. Original Equipment Manufacturer (OEM) systems that reduce crankcase emissions.
7. Regulatory aspects for methane emissions in engine exhaust.
8. Manufacturer-published methane emissions in engine exhaust; and
9. Technology options to reduce or capture methane emissions in engine exhaust.

No modifications are being made to the engines tested, this is a study rather than a demonstration.

D. PROJECT AND TECHNOLOGY KEY PERFORMANCE INDICATORS

Organization:	Current Study	Commercial Deployment Projection
Project cash and in-kind cost ($) (CanERIC alone)	$296,000	Undefined
Technology Readiness Level (Start / End):	Undefined	Undefined
GHG Emissions Reduction (kt CH_4/yr):	Undefined	4.9 MT CO_2e/year
Estimated GHG abatement cost ($/kt CH_4)	Undefined	Undefined
Jobs created or maintained:	Undefined	Undefined

E. RECOMMENDATIONS AND NEXT STEPS

The main outcomes when the project is complete will be a much better understanding of actual methane slip performance of engines provided by a team of experts in the area which can serve as input to potential regulations. In addition to field test results (being funded by AUPRF/CRIN over 2023), additional information will be provided from other published studies.

Best management practices and technology options will be developed for operators to optimized engine performance resulting in emissions reductions.

A full final report will be provided and shared with CanERIC at the end of the project.