

## Summary of Comments Received During Engine Fuel Management and Vent Gas Capture Protocol Public Posting (Jan 7<sup>th</sup> - Feb 7<sup>th</sup> 2009)

Comments Sorted by Category

### General Response to Comments:

In general, the comments relate to commercial concerns around the specific technology achieving the emission reduction and not to the methodology for measuring and quantifying the emission reductions. The specific technology or process used to achieve GHG reductions is not as important as the measurement process. Additionally, any technology that meets the broad scope defined by the protocol can follow the measurement and quantification procedures as part of the process to create offsets. This protocol, like all Alberta Offset System Quantification Protocols, has been designed to be agnostic to any one manufacturer's technology and instead applies to a specific emission reduction activity.

The protocol deals with measurements on existing field units recognizing that engine test cell protocols cannot be reasonably achieved. Measurement of the actual unit in its normal operating state provides a realistic before and after comparison and therefore enables a quantification of the change in fuel consumption achieved by the project activity.

	Section	Type of Comment	Category	Comment	Proposed Resolution	Alberta Environment Decision
1	General	Objection	General	A general comment - we believe that there are numerous errors and inconsistencies in the document that require a much more thorough technical review. We strongly believe that the protocol is not ready for approval at this time and should not be approved without additional review and revision.	<b>Not applicable</b> - comment does not provide sufficient detail to be addressed.	<b>N/A</b>
2	General	Clarification	General	There are numerous statements in the document that are either incorrect or misleading and that need to be corrected before the protocol is finalized. Modern gas engines are highly engineered pieces of equipment, and manufacturers must address numerous trade-offs when modifications are made regarding an engine's operational set points. Many of these decisions are optimized for specific applications and then adjusted to meet field	<b>Not applicable</b> - comment does not provide sufficient detail to be addressed.	<b>N/A</b>

				and fuel conditions. The complexity and need to evaluate these factors are not addressed in the protocol.		
5	General	Technical consideration	General	Under the protocol, the operating margin to “knock”, which is uncontrolled combustion in the engine cylinder, is reduced. This means that the engine is more likely to experience knock and may cause the engine to shut down or cause engine damage. This condition could have serious consequences. Moreover, increasing the Air/Fuel ratio on an engine designed to run at stoichiometric conditions increases the required air flow and thus may limit power capability and require an even larger engine to complete the same task. Additionally, these conditions will also increase heat rejection capacity with negative impacts on the engine.	<b>Not applicable</b> – any impacts on the engine caused by the project activity would not be applicable to the quantification as fuel consumption is already metered continuously. Negative impacts that result in increased fuel consumption and engine downtime would be captured by the protocol monitoring requirements. This comment has no effect on the protocol. Also there is no evidence to show that engine power is reduced.	<b>N/A</b>
6	General	Applicability	General	The alterations of engines as proposed in the protocol are likely to affect warranty requirements, and the protocol needs to address who is responsible for any damage to the engine from its application. The above points are just several examples of significant issues that engine manufacturers have identified with the proposed protocol. Initial review has identified others that require clarification or revision. Many technical issues need to be addressed before this protocol is correct and ready for approval.	<b>Not applicable</b> – Any warranty issues or damage to the engine caused by the project activity would be beyond the scope of the protocol.	<b>N/A</b>
7	Protocol Scope (Pgs. 1-6)	General / Objection	General	The scope of the Protocol (pg.1-6) is disjointed as only a commercial connection between quantifying GHG reductions from devices that re-insert vent gases and engine management systems exists. Furthermore, a separate quantification protocol for instrument gas to instrument air conversion has been submitted which has more continuity with vent gas mitigation than engine management system upgrades.	<b>Not applicable</b> – the protocol can be applied to both projects that capture vent gas and those that do not. For those projects that implement both an engine management system and a vent gas capture system, then this protocol simplifies the offset crediting process by not requiring two separate protocols for interlinked project activities. The re-insertion of vent gas into engines is an alternative to conversion to	<b>N/A</b>

					instrument air and requires the consideration of different sources of emissions. Project proponents that convert to instrument air may apply that protocol.	
8	Glossary Pg. 10	Technical Inaccuracy	General	<p>The definition given for an engine management system (pg. 10) is insufficient as only the air fuel ratio controller has been defined; neglecting the other available equipment, components and peripherals. Moreover, the definition ignores (one of) the most effective engine management goal; running an engine at its lowest speed and maximum Brake Mean Effective Pressure (“BMEP”) to minimize BSFC.</p> <p>The Protocol is inadequate relating to the management of air fuel ratio control; post-combustion oxygen levels in nearly all internal combustion engines are instantly governed, maintained and monitored by an oxygen sensor, yet the Protocol states that the oxygen levels need only be monitored, measured and recorded once a year.</p>	<p>The definition can be revised to say it may also include starting, ignition control, knock control, coolant temperature control as well as safety shutdowns. However, this definition does not impact the scope, applicability or quantification approach in the protocol.</p> <p><b>Not Applicable</b> - The use of an oxygen sensor would not change the quantification approach in the protocol. The air/fuel ratio is measured in the pre and post audits to ensure the validity of the baseline scenario, but would add unnecessary costs and burdens to monitor in the project condition since this data is NOT used in the quantification approach.</p> <p>Additionally, a number of newer engine management systems do not use oxygen sensors (e.g. Cat 3500LE), which deteriorate with time and require replacement.</p>	<b>Accept changes.</b>
1 2	General	Technical Quantification	General	<p>The method used in the Protocol to measure and calculate horsepower is limited to engines driving reciprocating compressors and the statement that “the mechanical power from the engine equals the power required by the load” is false as it may be affected by devices specific to the application. Using horsepower as a measurement of production also does not conform to the intensity based Net Emissions Intensity (“NEI”) equation fundamental to SGER. While using the least amount of fuel possible to create horsepower is important; BSFC does not account for how well the horsepower is actually being used. Running a</p>	<p><b>Not Applicable</b> – the SGER does not use an intensity basis specifically for compressors, instead aggregate facility emissions are divided by total production or inlet adjusted gas volumes. The protocol is more specific to compressors as it uses direct measurements of engine performance (hp) as compared to SGER, which lumps the estimated emissions due to engine fuel consumption in with a multitude of other emission sources when determining the emissions intensity. SGER does not require the measurement of fuel consumption for individual engines,</p>	<b>N/A</b>

				<p>machine in bypass will create good BSFC but does little work to the gas that is flowing through the machine. It can be likened to idling your vehicle's engine in the parking lot; which will reflect great BSFC, but does not generate any production (km's).</p>	<p>rather this is determined from the pro-rated facility fuel consumption and equipment ratings, which is less accurate than the methodology used in the protocol.</p> <p>The use of horsepower provides the most appropriate set of measurements that can be generically applied across engines using available measurements. Measurements are made pre and post implementation, and therefore the comparison between baseline and project conditions are consistent to ensure that site specific conditions are captured.</p> <p>The definition of BSFC is fuel rate (BTU/h) divided by load. Running a compressor in bypass reduces load and results in larger BSFC (see typical BSFC curves). When running your vehicle at idle, it has no load, and would mean that BSFC is very high or infinite.</p>	
14	General	Definition	General	<p>For example, lines 15-19 on page 10 of the protocol apparently define an engine management system as a device that controls engine air and fuel flows – the engine's air/fuel ratio. In reality, engine management systems can and do control a multitude of parameters including air/fuel ratio, ignition timing, knock control, turbocharger (if so equipped) operation, and may even map for engine emissions control and compliance.</p>	<p>Refer to the response to Comment 8, However, this doesn't impact the scope, applicability or quantification of methods in the protocol.</p>	<b>Accept changes.</b>
10	General	Technical	Emission Factor	<p>The link between fuel consumption and GHG reductions (pg.3) is unconvincing and inconsistent with CAPP, EPA and UN standards. Although the Protocol claims "to meet the measurement, monitoring and GHG quantifications requirements" (pg.1), it only references PTAC/Clearstone emission testing data that is incomplete and does not use EPA accepted test methods, testing equipment, testing duration, calculations or pre-post</p>	<p><b>The CO2 emissions are directly related to the quantity of fuel combusted and can be accurately predicted using published Emission factors as is done in all other Alberta protocols. The methane and N<sub>2</sub>O emission factors, which are technology specific, are discussed in a separate document, which examines CAPP, EPA, Environment Canada and empirical</b></p>	<b>Accept response.</b>

				<p>calibration. The handheld testing devices used have been rejected by the EPA for permit testing and proven inaccurate. The Protocol also suggests changing the combustion characteristics of the engine, from one extreme to the other (pg.1), and removing the catalytic converter (Technical Protocol Plan pg.16) but then uses the same static emissions factor for baseline and project calculations.</p>	<p><b>emission factors (analysis completed by Alberta Research Council) to validate the use of a static emission factor in this protocol. This discussion paper was not posted for public review and therefore this comment does not take into account the most to update supporting information on emission factors for this protocol.</b></p> <p>Note that the protocol does not require exhaust emission testing for quantifying GHG emissions and therefore the comment is not applicable. The costs of exhaust gas analyses would be prohibitive and likely exceed the value of the offsets created from these projects (ie 200 tonnes offsets per project would be typical).</p>	
9	General	Technical considerations	Emission factor & OEM	<p>The Protocol falls short in other areas;</p> <p>i) not specifically measuring emission components, then trying to establish that fuel management will deliver GHG reductions, without actually measuring the emissions, and</p> <p>ii) deriving specific unit horsepower and BSFC through awkward and incomplete field tests, as opposed to relying on Original Equipment Manufacturer's ("OEM") or other widely recognized industry standardized, and proven methods of providing this important data for any engine regardless of age and/or location.</p>	<p><b>Protocol emission factors are discussed in a separate document, which examines CAPP, EPA, EC and empirical emission factors to validate the use of a static emission factor in this protocol. This discussion paper was not posted for public review and therefore this comment does not take into account the updated information on emission factors.</b></p> <p>OEM data is not suitable for use due to site to site variations as discussed in comment #17. The protocol's methods used to determine actual power output of a field engine (compressor analysis, generator power output) are industry accepted. The fuel measurement is performed using calibrated devices and laboratory fuel analyses.</p>	<b>Accept changes.</b>
17	Page 2	Technical / Clarification	OEM	<p>In another area, the protocol on page 2, lines 33-36 and the referenced module 7 on page 8 state that field fuel consumption can easily be "up to 30% higher" than the ideal,</p>	<p><b>Not applicable</b> – It is well recognized that manufacturer's engine ratings and fuel consumptions are performed according to standard conditions, as compared to field</p>	<b>N/A</b>

				<p>manufacturer's published, values. Manufacturer published engine ratings and fuel consumption are based on ISO or other, standard conditions – not "ideal" conditions. <b>Obviously this does not take into account site specific conditions, fuel quality, or engine settings; all of which will be different in the field.</b></p> <p>Standard manufacturer data should not be used as a reference for comparison to site conditions. Even so, engines typically do not vary as much as 30% higher fuel consumption as it seems obvious in the fact that the impact of fuel costs (economics) would prohibit projects from applying an engine.</p>	<p>testing which shows the condition of the engine as it is operating. As stated in the bold highlighted portion of the comment, OEM data does not apply to site-specific conditions and therefore the protocol's use of site specific field measurements improves accuracy.</p>	
1 1	Page 2-3.	General / Technical Quantification	OEM	<p>The quantification of fuel consumption in this Protocol does not account for many engine performance variables and thus will allow easily skewed baseline measurements. For example, retarding ignition timing for the baseline and then advancing it for the project measurements will greatly distort the "fractional fuel saving"(pg.3).</p> <p>The OEM fuel consumption values are derived from rigorous testing under heavy engineering scrutiny and well established international standards. Unless the engine is improperly tuned or very poorly maintained, it is unfair to imply that OEM fuel consumption numbers are amiss by 30% (pg.2). Engine OEM's have well established methods and procedures to rationalize site-specific variations in BSFC as compared to standard test conditions, which have been neglected in this Protocol.</p>	<p><b>Not applicable</b> – the project proponent is required to perform pre and post audit measurements to avoid any skewing of the baseline. These measurements are recorded in the project documentation and would be verified by a third party auditor. The ignition timing (ignition advance) is recorded during the pre and post audits to ensure that the baseline scenario is accurate. It is expected that these tests would be performed in a professional manner to exclude adjustments made specifically for the tests.</p> <p><b>Not applicable</b> – as discussed in Comment #17, OEM data is not applicable for site specific comparisons. Note that the reference to the 30% value was removed prior to public posting of the protocol and therefore this comment is based on an outdated version of the document.</p>	<p><b>Accept response.</b></p> <p><b>Accept response.</b></p>
3	Page 47. Figure B1	General / Technical consideration	NOx	<p>The protocol and Module 7 appear to ignore the impacts of changing the operating point to reduce fuel use on other parameters, particularly non-GHG emissions. In the stoichiometric case on Page 47, Figure B 1,</p>	<p><b>Not applicable</b> – Alberta Environment has other regulations in place to control the release of criteria air contaminant emissions, which are beyond the scope of this protocol which focuses solely on the</p>	

				the suggested protocol may produce a leaner engine but results in increased NOx emissions in the range of 5-10 g/bhp-hr. This will result in the NOx emissions exceeding the emission limit of 4.5 g/bhp-hr in Alberta and thus putting the engine and operator in noncompliance.	<p>quantification of GHG emissions. Exceeding the Alberta NOx limits would be dealt with outside of the protocol and the Alberta SGER.</p> <p><b>Accept response.</b></p> <p><b>Note: Alberta Environment will consider this issue upon final review.</b></p>
4	General	Technical consideration	NOx	There is no discussion of the impacts of the proposed protocol and the resulting lean-burn condition on other emissions such as NOx. These are important issues that cannot be ignored. For example, rich burn engines use non-selective catalytic reduction (NSCR) systems in order to meet NOx emissions requirements. If the draft protocol is applied to an engine, the resulting lean combustion conditions will no longer be appropriate for NSCR systems, and selective catalytic reduction (SCR) systems will have to be added in order to meet regulatory emissions limits. This is a significant increased cost to the owner/operator, and such consequences are not considered nor addressed in the protocol.	
13	Editorial	Technical	NOx	Our major concern is that both documents contain incomplete, ambiguous, and misleading technical information and statements. Both documents emphasize reduction of fuel consumption (Brake Specific Fuel Consumption – BSFC) as a means to reduce Greenhouse Gasses (GHG) using air/fuel ratio change to the apparent exclusion of the effects that this would have on other exhaust emission values, NOx, etc., and important engine performance characteristics such as stability and load acceptance.	
15	Page 1, lines 12-17	General / Technical	NOx	The protocol on page 1, lines 12-17, implies that engines can be operated at an air fuel ratio different than original design resulting in easily obtained fuel consumption and GHG reductions. In principle that is true. In practice, however, many engine characteristics are affected and the entire picture must be	

				evaluated. Refer to Figure B.1 on Page 41 and Case Study III: Lean Burn Conversion on page 60, both in the module 7 document. Figure B.1 and notes imply that the lean burn region (#3) will meet NOx limits. That probably is incorrect. At the approximately 800-1600 ppm NOx shown, Alberta's 4.5 g/bhp-hr NOx limit will likely be exceeded. Refer also to the Case Study tabulation, which shows clearly NOx levels ranging from 16-24 g/bhp-hr (neglecting the one zero value which is obviously in error). These values are well above the 4.5 g/bhp-hr limit.		
1 6	Appendix	Editorial/ Technical	NOx	Refer now to Appendix C-2 on page 74 of the protocol. Waukesha believes that Table C-2.1 is misleading and contains measurement errors. Changing from the pre-audit 1.08% oxygen to the post audit 6.20% value shown in Table C-2.1 appears to show improvement in all measured parameters. However, compare the 3.43 g/bhp-hr NOx rate here at 6.2% oxygen with the values of Case Study III just discussed that are significantly higher at similar oxygen levels. The former would meet the 4.5 g/bhp-hr Alberta NOx requirement while the latter would exceed it by a large margin. Also, Table C-2.2 shows zero unburned hydrocarbons (HC) at the 6.2% oxygen setting. It.....		
<b>Comments and Responses from Stakeholder Session held March 17, 2009</b>						
1				Revisions to the Protocol - definition work on engine fuel management	Updated the definition of engine management system on page 10	Accept
2				Revisions to the Protocol - Flexibility mechanisms; Jamie C to provide more wording around how to treat constant speed engines, to broaden scope which would include GenSets etc	Added wording on engines operating at constant speed on page 3. Also added a flexibility mechanism (#4) on page 9 to clarify the point again.	Accept
3				Revisions to Protocol - Jamie C to provide tighter language for determining impacts of Parasitic load in baseline configuration and project configuration so parasitic power is not misrepresented.	Added wording to the 1st applicability criteria on page 4, to ensure project proponents account for parasitic loads and auxiliary equipment in an	Accept

					<p>appropriate way during the pre and post audits.</p> <p>Added wording on page 61 to say the same thing about the need to track changes to equipment that could distort pre and post audit results.</p>	
4				<p>Cautionary wording about the potential to increase NOx emissions as a result of implementing this protocol was strongly recommended by the Engine manufacturers. Alberta Environment will take this under consideration.</p>	<p>Have not added any cautionary wording on NOx emissions as this is best for Alberta Environment to provide applicable wording to address</p>	Accept
5				<p>Further work may be required depending on Alberta Environment evaluation - use of static N2O emission factor flagged by the group. The correlation of NOx and N2O under richer burn conditions (baseline) and lean burn conditions (project) on engines was not settled and called into question the assumption of a static emission factor for N2O. US EPA AB42 was cited.</p>	<p>Revised the existing flexibility mechanism (#5) to allow for dynamic emission methane and N<sub>2</sub>O factors (i.e. different ones for the project and baseline) provided that measurements are taken at each load and RPM.</p> <p>The protocol still uses static N2O emission factors (with the exception of the new flexibility wording to allow dynamic factors if the Project Developer chooses to do so).</p>	Accept
6				<p>This may also impact the need to have an O2 sensor on the exhaust side of the engine, but older engines and retrofits may be an issue. It also wasn't clear what benefit the O2 sensor could provide if an appropriate emission factor between baseline and project could be arrived at.</p>	<p>Not addressed the issue of an O2 sensor in the protocol. This is a technology specific (commercial) issue that would be too prescriptive to input into the protocol as not all engines will have O2 sensors and not all engine management systems will have O2 sensors (i.e. this is like the protocol telling someone that they have to buy a certain brand of meter).</p>	Accept
				Additional	Added wording and an equation for	Accept

				<p>Note that this was not something that came up in the review, but it does increase the accuracy of the protocol slightly and the reference is directly from CAPP. This is a well agreed upon approach and is different from the CH4 and N2O discussion and was only added for technical accuracy (ie down to the last molecule).</p>	<p>project proponents to calculate a site specific CO<sub>2</sub> emission factor. It takes the exact carbon content of the gas (from an annual gas analysis) and converts that into a CO2 emission factor based on the mole fractions of each carbon-containing compound.</p>	
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