



**TECHNICAL PROTOCOL PLAN (TPP) FOR
QUANTIFICATION PROTOCOL FOR
INSTRUMENT GAS TO INSTRUMENT AIR CONVERSION
IN PROCESS CONTROL SYSTEMS**

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PART A IDENTIFICATION OF THE PROTOCOL DEVELOPER Error! Bookmark not defined.

- A.1. Title of the Proposed Protocol: **Error! Bookmark not defined.**
- A.2. Lead Protocol Developer: **Error! Bookmark not defined.**
- A.3. Initiating Entity: **Error! Bookmark not defined.**

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PART B DESCRIPTION OF TECHNICAL PROTOCOL PLAN CONTENT

This section is an overview of the Protocol including: project type, project-specific technology, quantification methodology and how the projects using the protocol will reduce GHGs.

B.1. Description of the Project Type: *(The project type is a set of project practices or technologies that represent the change from a normal business operation/practices or common industry practice.)*

Introduction

Pneumatic controls are used in the natural gas and oil industry for process control. These devices use natural gas to supply pressure. Once the gas has passed through the instrument, it is left to *vent* and *bleed* to the atmosphere. In some facilities, vented gas may also be collected and sent to a flare or combustion source. Because pressurized natural gas is readily available at most facilities, it has become the supply source of choice among operators in these industries. Natural gas is typically sourced from the fuel supply for the facility. This fuel gas is processed natural gas. This control has been very popular in industry because of simplicity, reliability, and familiarity of instrumentation for field operators to adjust and to repair, unavailability of electricity for electrical instrumentation, and high replacement costs. In industry, the term vent is commonly used to refer to both vent and bleed gas. For this TPP and proposed protocol, vent gas will be used to refer to the sum of vent and bleed gas. The following quote best describes the current circumstances in the oil and gas sector.

“There has long been a misunderstanding in the industry that the amount of gas pneumatic controllers bleed is insignificant. Work performed for the United States Environmental Protection Agency has shown that the largest source of methane emissions in the industry comes from pneumatic instrumentation. Fifty percent of all vented gas and 15 to 20 percent of total emissions in the United States (U.S.) are said to come from pneumatic instrumentation. The production segment accounts for 69 percent of these emissions in the US and it is likely that a similar percentage applies in Canada. Gas storage and transmission account for most of the remainder. In the US, venting from pneumatic instruments is estimated to be in the order of 61 billion standard cubic feet (Bscf) per year. In Canada the estimate is between 12 and 25 Bscf per year of gas being vented to the atmosphere through pneumatic instrumentation. Assuming a price of CND\$6 per 1000 scf, the value of vented gas is between \$75 and \$150 million collars per year.

There are about 100,000 gas wells in Western Canada, the majority in remote locations without power. Although pressurized natural gas is the primary power source for pneumatic controllers, about 30 percent of the wells are sour gas wells which use bottled propane as the energy source to drive pneumatics. Propane venting, like natural gas, adds to both the cost and environmental impact of operating pneumatic devices. In many cases propane is much more costly than natural gas due to trucking and logistics.”¹

This Technical Protocol Plan (TPP) is targeted at projects that convert natural gas to air to power pneumatic devices in process control systems. In the vast majority of cases, vented natural gas will consist primarily of methane with smaller amounts of carbon dioxide, both potent greenhouse gases, and trace gases. By converting the system and using air, bleeding and venting of these greenhouse gases are eliminated. For this to happen, an air compression system must be in place. Air compression and other activities within the project may generate minor quantities of greenhouse gases.

¹ CETAC WEST (2008). Fuel Gas Best Management Practices: Efficient Use of Fuel Gas in Pneumatic Instruments- Module 3 of 17.

This protocol is applicable to facilities that use natural gas to power pneumatic instruments and plan to replace the natural gas with air to power pneumatic instruments in process control systems. These may include oil and gas wells, oil producing and gas processing facilities, and gas pipelines. The protocol may also be used to reduce emissions from chemical injection pumps as well. Potential users include oil and gas operators.

Description of how real reductions or removals will be achieved: *(The Protocol Developer must ensure the GHG(s) that will be reduced by the activities for this project type are within the scope and criteria of the Alberta Offset System.)*

Project proponents must demonstrate that they can meet the Alberta Offset System eligibility criteria as specified in Alberta Carbon Offset Solutions' "Offset Credit Project Guidance Document". **TABLE B. 1** summarizes the criteria and justifications for eligibility.

TABLE B. 1 Criteria and Justification for Protocol

Criteria	Justification
Results from actions taken on or after January 1, 2002	Projects will be implemented after this date.
Credited on or after January 1, 2002	Projects will be implemented after this date and credited for a period of 8 years.
Are real, demonstrable, and quantifiable	Project emissions will be based on metered quantities that can be verified. In addition, vented gas will be eliminated by substituting the natural gas supply source with air. Quantification of volumes will follow established scientific approaches and best available science.
Are not required by law	No regulations or laws require the conversion of pneumatic instrument gas use to pneumatic air use. As a result, projects applying the proposed protocol are incremental to existing laws and regulations. See section B.3 for details.
Have clear ownership	Facilities are within company operations and it is the responsibility of the project developer to demonstrate ownership.
Will be accounted once for compliance purposes	Projects will be registered in Alberta's Offsets System Registry.
Will be verified by a qualified third party	Offsets will be verified by a third party.
Will have occurred in Alberta	Projects will be commissioned in Alberta.

B.2. Description of Background Information/Best Practice Guidance Used:

Written documents, websites, personal contacts with industry experts and greenhouse gas reduction programs were consulted in order to prepare this TPP and the proposed protocol. These resources will be used to incorporate important aspects of greenhouse gas elimination from instrument venting and bleeding in the development of the proposed protocol. **TABLE B. 2** is a summary of the resources used.

TABLE B. 2 Good Practice Guidance

1. Document Title	2. Publishing Body/Date	3. Description
1. Methane Emissions from the Natural Gas Industry- Volume 6: Vented and Combustion Source Summary	USEPA Document # EPA-600/R-96-080f, June, 1996	Provides a summary of volumes vented from the natural gas industry and percentage of pneumatic gas and compressed air devices used in the production processing, transmission and

		distribution sectors.
2. Lessons Learned: Convert Gas Pneumatic Controls to Instrument Air.	USEPA Document # EPA-430-B-04-003, February, 2004	Provides a summary on technical and economic aspects of conversion of pneumatic gas powered control instruments to air.
3. Lessons Learned: Options for Reducing Methane Emissions from Pneumatic Devices in the Natural Gas Industry.	USEPA Document # EPA-430-B-03-004, July, 2003	Provides a summary on technical and economic aspects of conversion of pneumatic gas powered control instruments from high bleed to low bleed devices.
4. Fuel Gas Best Management Practices: Efficient Use of Fuel Gas in Pneumatic Instruments- Module 3 of 17.	CAPP-CETAC WEST, May 2008	Provides information on basic improvement strategies, inspection, monitoring and record keeping, feasibility assessment, operation checks, testing, and adjustments for pneumatic instruments in field and gas operating facilities as well as statistics.
5. Fuel Gas Best Management Practices: Efficient Use of Fuel Gas in Chemical Injection Pumps- Module 5 of 17.	CAPP-CETAC WEST, May 2008	Provides information on basic improvement strategies, inspection, monitoring and record keeping, feasibility assessment, operation checks, testing, and adjustments for chemical injection pumps in field and gas operating facilities as well as statistics.
6. Technology Demonstration Report-Sirius Emissions Reducer	CETAC WEST, March 29, 2005	Provides an alternative to reduce emissions, also statistics on emission volumes in Alberta.
7. Compendium for Greenhouse as Emissions Methodologies for the Oil and Gas Industry.	American Petroleum Institute (API), February 2004.	Provides emission factors and methodologies on how to estimate greenhouse gases from the oil and gas industry.
8. Guide-Estimation of Flaring and Venting Volumes form Upstream Oil and Gas Facilities	Canadian Association of Petroleum Producers (CAPP), May 2002	Provides a simple methodology on how to estimate vented emissions from pneumatic devices and gas operated chemical injection pumps with emissions factors.
9. Guide-Calculating Greenhouse Gas Emissions	Canadian Association of Petroleum Producers (CAPP), April 2003	Provides information on bleed rates for high bleed devices.
10. A Recommended Approach to Completing the National Pollutant Release Inventory (NPRI) for the Upstream Oil and Gas Industry	Canadian Association of Petroleum Producers (CAPP), March 2007	Provides a simple methodology on how to estimate vented emissions from pneumatic devices and gas operated chemical injection pumps with emissions factors.
11. Toward a Consistent Methodology for Estimating Greenhouse Gas Emissions from Oil and Natural Gas Industry Operations	American Petroleum Institute (API), 2002	Provides a comparison of 4 different protocols from 10 different associations for emissions from pneumatic instruments in a production gathering compressor station. Protocols included:

		<ul style="list-style-type: none"> • Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry (API (American Petroleum Institute), 2001); • Canadian Voluntary Challenge Guide (CAPP (Canadian Association of Petroleum Producers), 2000); • EIIP (Emission Inventory Improvement Program), (USEPA (United States Environmental Protection Agency), 1999); and • Atmospheric Emissions Inventories Methodologies in the Petroleum Industry (ARPEL (Regional Association of Oil and Natural Gas Companies in Latin America and the Caribbean), 1998).
12. Discussion Paper for a Natural Gas Transmission and Distribution Greenhouse Gas Reporting Protocol	California Climate Action Registry, WRI (World Resources Institute), June 6, 2007	Provides Emission Factors for various types of pneumatic devices.
13. A Comprehensive Oil and Gas Emissions Inventory for the Denver-Julesburg Basin in Colorado	ENVIRON, Buys and Associates, and IPAMS, February 7, 2008	Provides a simple methodology on how to calculate annual vented volumes based on device vent rate, as characteristics, and operational time of device per year.
14. New Approach to Control Valve Sizing	Driskell, L.R., Hydrocarbon Processing, Vol. 48, No. 7, July, 1969, p.131-134	Provides equations and procedures on how to predict gas behaviour in control instruments.
15. Sizing Valves for Gas Flow	Driskell, L.R., ISA Transactions, Vol. 9, No. 4, 1970, p.325-331	Provides equations and procedures on how to predict gas behaviour in control instruments.
16. ANSI/ISA-75.02-1996 Control Valve Capacity Test Procedures	ISA, 1996	Provides a test procedure for obtaining the following factors for sizing control valves: valve flow coefficient (CV); liquid pressure recovery factors (FL and FLP); Reynolds Number factor (FR); liquid critical pressure ratio factor (FF); piping geometry factor (FP); and pressure drop ratio factors (XT and XTP). The standard is intended for control valves used in flow control of process fluids and is not intended to apply to fluid power components as defined in the National Fluid Power Association Standard NFPA T.3.5.28-1977.
17. ANSI/ISA-75.01.01 (IEC 60534-2-1 Mod)-2007 Flow Equations for Sizing Control Valves	ISA, 2007	ANSI/ISA-75.01.01 (IEC 60534-2-1 Mod)-2007 includes equations for predicting the flow coefficient of compressible and incompressible fluids through control valves.
18. Methane Emissions from the Natural Gas Industry	USEPA Document # EPA-600/R-96-0801, June, 1996	Provides information on pneumatic device characteristics, device emission factors from the production, gas processing, and transmission and storage segment of the gas industry.
19. ISO 14064-2 Standard	International	Provides specification with guidance at the

	Standard Organization, 2006	project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.
20. The GHG Protocol for Project Accounting	World Business Council for Sustainable Development-World Resource Institute, ca. 2003.	Provides background, concepts, and principles on how to develop GHG reduction projects, with example and definitions.
21. Canada's Offset System for Greenhouse Gases-Guide for Developers (Draft for Consultation)	Environment Canada, August 2008	Provides background, concepts, and principles on how to develop an Offset System Quantification Protocol (OSQP) in Canada.
22. Greenhouse Gas Emission Reduction Opportunities for the Upstream Oil and Gas Sector and the Gas Pipeline Sectors on British Columbia	Pembina Institute, July, 2000	Provides idea on opportunities to reduce vented lists some gas to air conversion projects in Canada.
1. Site Title	2. Program Name	3. Description
1. http://www.carbonoffsetsolutions.ca/offsetprotocols/financialAB.html	Alberta Environment and Climate Change Central (C3)	Provides numerous examples of approved protocols for Alberta's offset market.
2. http://cdm.unfccc.int/index.html	United Nations Framework Convention on Climate Change	Provides numerous examples of approved protocols for the UNFCCC carbon offset program using the Clean Development Mechanism and Joint Implementation as well as statistics from these offset mechanisms.
3. http://www.ercb.ca/portal/server.pt?	Energy Resources Conservation Board (ERCB)	The Energy Resources Conservation Board (ERCB) is an independent, quasi-judicial agency of the Government of Alberta. It regulates the safe, responsible, and efficient development of Alberta's energy resources: oil, natural gas, oil sands, coal, and pipelines.
4. http://www.epa.gov/gasstar/	USEPA- Natural Gas Star Program	Internet website with information on GAS STAR program. Through the Program, EPA works with companies that produce, process, and transmit and distribute natural gas to identify and promote the implementation of cost-effective technologies and practices to reduce emissions of methane, a potent greenhouse gas.
5. http://www.methanemarkets.org/	Oil and Gas Systems	The Methane to Markets Partnership is an international initiative that advances cost-effective, near-term methane recovery and use as a clean energy source. The goal of the Partnership is to reduce global methane emissions in order to enhance economic growth, strengthen energy security, improve air quality, improve industrial safety, and reduce emissions of greenhouse gases. The Partnership acts as a mechanism to bring together interested parties from governments and the private sector to facilitate methane project development and implementation around the

1. Expert Name	2. Title	3. Description
1. Krista Phillips	CAPP	Provided insight into air conversion projects in consideration by CAPP members.
2. Steve Lawson	WellMark Co. Representative	Provided insight into the way pneumatic devices work, and technologies used.
3. Jeff Seaborne	Spartan Controls Engineer	Provided insight into the way pneumatic devices work, and technologies used in Alberta as well as gas equivalency.
4. Tim Hearn	Sirius Instrumentation and Controls Inc.	Provided insight into the way pneumatic devices work, and technologies used in Alberta, made presentation to PTAC about pneumatic devices and emissions control.
5. Gerald Palanca	Engineering Technologist at Petro Canada	Provided insight into the way pneumatic devices work, and technologies used in Alberta, in particular by Petro-Canada.
6. Milos Krnjaja	Energy Efficiency Specialist, BP Canada	Provided insight into the way pneumatic devices work, and technologies used in Alberta, in particular by BP Canada.
7. Suzie Waltzer	USEPA- Natural Gas Star Program	Provided insight into the way pneumatic devices work, and technologies used in the USA, as well as sending relevant documentation and researching areas EnCana Corporation requested.

B.3. Regulatory, Legal Requirements and/or Government Incentive/Grant Programs:

List of potentially relevant regulations/legal requirements:

Provincial

- Energy and Resources Conservation Board (ERBC) Directive 17: “Measurement Requirements for Upstream Oil and Gas Operations”- *Directive 060* provides regulatory requirements and guidelines for flaring, incinerating, and venting in Alberta, as well as procedural information for flare permit requests, dispersion modeling, and the measuring and reporting of flares, incinerated, and vented gas. In addition to upstream petroleum industry facilities, the directive also applies to gas transmission facilities license by the EUB.
- Energy and Resources Conservation Board (ERBC) Directive 060: “Upstream Petroleum Industry Flaring, Incinerating, and Venting”- *Directive 017* consolidates, clarifies, and updates Alberta Energy and Utilities Board (EUB) requirements related to the measurement of fluid (gas and liquid) production and disposition associated with upstream petroleum operations. The term “measurement” as used in this document means “measurement, accounting, and reporting.” While measurement is the determination of a volume, accounting and reporting are integral components of measurement in that after a fluid volume is “measured,” mathematical procedures (accounting) may have to be employed to arrive at the desired volume to be “reported.”

List of potentially relevant climate change incentives:

Provincial

- Climate Change and Emissions Management Act- This Act gives the Minister powers to establish the specified gases, targets and other legal matters such as offsetting, reporting, programs, cooperation, and establishment of other requisitions such as the Specified Gas Emitters Regulation.
- Specified Gas Emitters Regulation- This regulation created under the Climate Change and Emissions

Management Act establishes emissions intensity limits, true-up, offsets, fund credits, reporting, audits, baselines, exemptions and expirations related to greenhouse gas emission among other specifics such as greenhouse gases and their global warming potential.

Alberta Carbon Offset System

Alberta is the first jurisdiction in North America to require industries to reduce their greenhouse gas emissions. Alberta facilities emitting more than 100,000 tonnes of greenhouse gases a year must reduce their emission intensity by 12 % a year under the recently amended Climate Change and Emissions Management Act. The reduction, which includes facilities in the energy, chemical and electricity sectors, came into effect July 1, 2007.

Under this act, three options to handle exceeding emission can be applied:

1. Emission Performance Credits- A company can obtain performance credits (buy, trade, etc.) from other regulated companies that reduced their emissions more than they needed to;
2. Tech Fund Credits- A company can pay into the Climate Change and Emissions Management Fund at a set price of \$15/tonne CO₂e. The funds collected are to be used to develop or invest in Alberta based technologies, programs, and other priority areas; and
3. Emission Offsets- A company may offset their emissions by purchasing emission reduction offsets. It is voluntary (they do not have to purchase them). However, the offsets must be from Alberta and must be approved offsets (approved quantification protocols by Alberta Environment).

In Alberta, the project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System. Of particular note:

- a. The date of equipment installation, operating parameter changes or process reconfiguration are initiated or have effect on the project on or after January 1, 2002 as indicated by facility records;
- b. The project may generate emission reduction offsets for a period of 8 years unless an extension is granted by Alberta Environment, as indicated by facility and offset records. Additional credit duration periods require a reassessment of the baseline condition; and
- c. Ownership of the emission reduction offsets must be established as indicated by facility records.

Commentary on Regulatory, Legal Requirements and/or Government Incentive/Grant Programs

Vented gas from pneumatic controls or instrumentation is not required by law to be reported as vented gas but rather as part of the fuel supply under the Energy and Resources Conservation Board (ERBC) Directive 17:

“All gas usage, such as for instrumentation, pumps, and heating, must be reported as fuel use on a per-site basis, even if it is vented afterwards. The volume must be measured on a per site basis if over 0.5 10³ m³/d or may be estimated if not over 0.5 10³ m³/d (see Figure 1.11). If there are multiple reporting facilities on the same site, the fuel use has to be separately reported to each individual facility but there must be overall site fuel measurement.”

Fuel gas is processed gas used for facility operations. This leaves the possibility of using natural gas for instrumentation and venting it afterwards. However, any leaks or fugitive emissions for instrumentation are regulated under Directive 060, section 8.7 “Fugitive Emissions Management, which states

“1) Operators must develop and implement a program to detect and repair leaks.

a) These must meet or exceed the CAPP Best Management Practice for Fugitive Emission

Management.”

In reviewing the legal documentation that might affect the development of this project, there were no regulations that will have a foreseeable affect in the implementation of air conversion project. Only regulations regarding leaks may affect these kinds of projects. This is considered an advantage for the proposed protocol. It forces the operator to implement a program that will reduce leaks. When this happens and air or natural gas from instrumentation is metered, the volumes will be inferior to those had a program of this nature not been enforced by regulation. So, a positive effect of this regulation is that it will make fuel gas use more conservative and efficient and consequently quantified emissions will be conservative. The protocol would also be incremental to any established laws or regulations.

B.4. Barriers and Risks to Implementation:

Identified barriers are barriers that should include anything that would discourage a decision to try and implement the project activity. The project faces barriers that stem from various sectors such as financial, technological, infrastructure, and market structure, social, among others. These barriers are summarized in **TABLE B. 3**. Barriers can stand alone in one of these categories or combine to affect other barrier types. Even if a financial and budgetary barrier is not present, other barrier types may preclude the implementation of the project.

TABLE B. 3 Summary of barriers to implementation

Barrier type	Description
Financial and Budgetary	<ul style="list-style-type: none"> • Scare resources to allocate funds for air conversion projects may hamper materialization of projects because resources are used for other priority areas such as new exploration and production projects.
Technology Operation and Maintenance / Technology Transfer	<ul style="list-style-type: none"> • Additional on-site personnel may be required to implement and manage the logistics of this technology; • Shutdown time during implementation may affect operations and saleable gas, resulting in revenue loss; • Technology transfer from vendor to project operator may be delayed by unforeseen factors during training and startup.
Infrastructure/ Resource availability	<ul style="list-style-type: none"> • Lack of energy source to power compressor system, especially in remote areas; • Limited access to facility for maintenance during adverse weather conditions in case of emergencies, especially during winter where remote areas are harder to access and service; • Sudden loss of power source due to unforeseen events; • Lack of infrastructure to install compressor system.
Market Structure	<ul style="list-style-type: none"> • Uncertainty of how the provincial/federal carbon market will evolve may lead proponents to delay project execution; • Lack of available parts in local markets; • Unforeseen increase in demand may cause shortage and delays in project implementation.
Institutional/Social/ Cultural/Political- Staffing	<ul style="list-style-type: none"> • There may be a potential unwillingness to commit to changing current proven system within an organization; • Lack of field personnel willing to take responsibility of new installed system, seen as too much extra work for same pay;
Others	<ul style="list-style-type: none"> • Although minimal, there is a potential increase in noise levels.

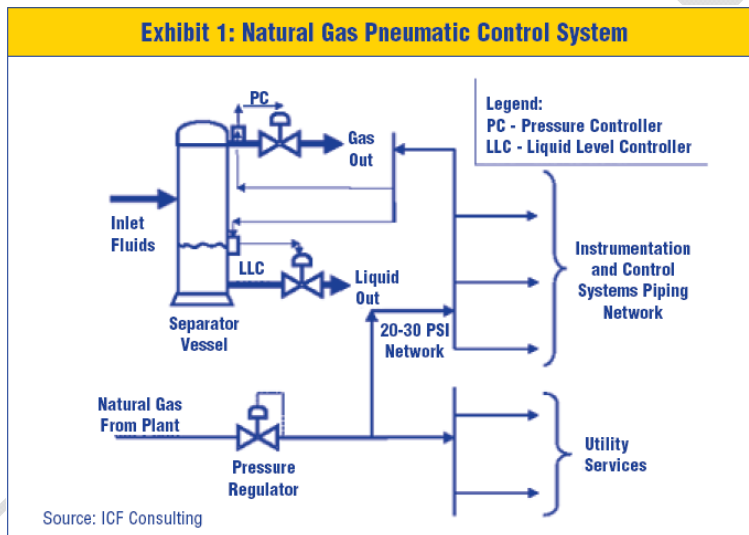
B.5. Review of Technology/Scientific Knowledge:

Pneumatic devices release vent or bleed natural gas into the atmosphere as part of regular operations.

Devices that use natural gas include pressure controllers, differential pressure controllers, temperature controllers, and liquid level controllers. Within the control device, transducers, positioners, switches, and transmitters also bleed small amounts of natural gas.

The pneumatic control system consists of the process control instrument and valves that are operated by natural gas regulated at roughly 20-30 psi of gas, and a piping network that distributes gas to all of the control instruments. Supply gas is clean, dry, pressurized and kept at a constant temperature. Part of the stream is also used for a small number of utility services such as pneumatic pumps, compressor motor starters, and isolation shutoff valves. This supply gas supply is used both as a signal and power supply.

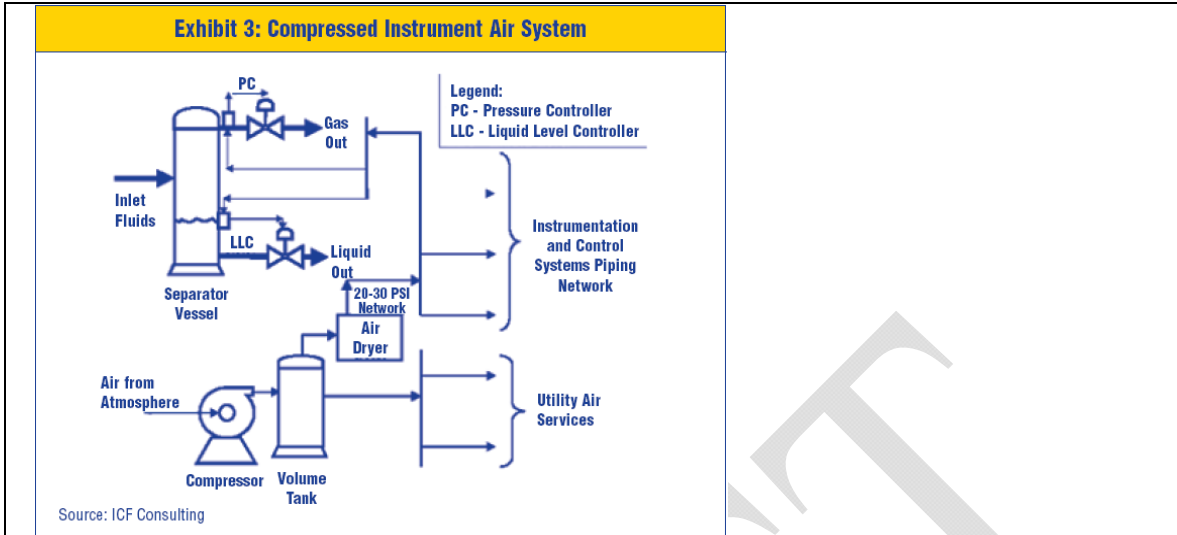
A liquid level controller can be used as an illustrative example. In a separator tank, process condition is checked by a float that is mechanically linked to the liquid level controller outside the tank. An upward or downward change in the liquid level triggers the float, which is conveyed to small needle valves inside the controller. Pneumatic gas supply is either directed to the valve actuator by the needle valve pinching off an orifice, or gas pressure is bled off the valve diaphragm connected by a rod to the valve plug, causing the plug to open and increasing the flow of liquid draining out of the separator tank. Gas pressure relieved from the valve actuator allows a spring to push the valve plug closed. This is illustrated in **FIGURE B. 1.1**. Continuous release of natural gas is referred to as *bleed* or *leaked* gas. Gas that is released because of cycling of the actuator is referred to as *vented* gas. Consequently, there are one or two sources of greenhouse gas emissions for any given pneumatic device depending on the design. In industry, both vented and bleed gas are lumped together can called vented gas.



Source: EPA Natural Gas Star (2003). Lessons Learned-Converting Gas Pneumatic Controls to Instrument Air.

FIGURE B. 1 Natural gas venting from a liquid level controller

The project will use the same principles, with the exception that air will replace natural gas as the pressure source. In order to compress the gas, there will need to be an air compressor system installed, as well as a volume tank to store compressed gas. The use of an air dryer or desiccant is recommended to remove air and minimize corrosion to the piping network and devices. The configuration of the new system can be appreciated in **FIGURE B. 2**. Note the similarity in functions to natural gas driven devices.



Source: EPA Natural Gas Star (2003). Lessons Learned-Converting Gas Pneumatic Controls to Instrument Air

FIGURE B. 2 Compressed air used to power a liquid level controller

These two systems use gas as a power source. Other technologies can be implemented for process control. This includes:

- Liquid nitrogen- Nitrogen is used to supply gas to the pneumatic devices. Nitrogen gas is cooled down to a liquid form by a cryogenic system. This type of instrument control system therefore requires bottles of nitrogen that must be replaced periodically, in addition to a cryogenic system capable of handling this gas. These systems can be expensive and pose potential safety hazards.
- Mechanical controls- These control devices do not use pneumatic or electric components. Instead, they operating using springs, levers, baffles, flow channels and hand wheels. They are simple in design and do not require a power source to operate. These control devices have several disadvantages, which include limited application, need for constant calibration, lack of sensitivity, incapable of handling large fluctuations, and potential for parts to stick.
- Electric and electro-pneumatic devices- These devices are increasing in use in industry due to technological advancements and increased sophistication. A constant electrical power supply is needed to power these instruments. They are very safe because they do not require compression of gases. However, they need an uninterrupted source of energy to function, and are costlier than other devices.
- Low bleed/no bleed devices- As their name indicates these devices bleed low or no gas at all. In most cases, devices already in operation are retrofitted with special valves to reduce, and in many cases, eliminate bleed gas. Their popularity is increasing, but valves are device-specific, meaning that many devices still do not have valves that can be retrofitted to them. No bleed valves only vent gas, bleed gas is completely eliminated. Mizer valves are a name type used to commercial them. Combination of these devices with pneumatic gas or air is a growing trend.
- Propane-Some instruments run on bottled propane, but those that do are very few in number, mostly for sour gas wells.

B.6. Review of Existing Projects: *(Review of trends and statistics on existing practices/projects in the Alberta and/or Canadian context.)*

Overview

In reviewing the existence of possible air conversion projects, it was noted that access to information was limited and therefore it is difficult to quantify how many air conversion projects have been historically implemented. This is due to the fact that that fuel gas use in pneumatic instruments is not required to be

metered. Consequently, volumes of vented gas cannot be quantified. Some projects do exist in Canada.

Existing Projects

The following is a list of air conversion projects have been implemented by oil and gas companies and associated emissions reductions based on publicly available information and EnCana Corporation's internal database:

- BP-42,000 tCO₂e/yr reduction from various technologies including air conversion projects².
- PennWest Energy Trust- about 11,800 tCO₂e/yr from about 15 air conversion projects implemented between 2000 and 2006³
- EnCana Corporation-
 - About 29 projects in Alberta with less than 600 tCO₂e/yr per project⁴.
 - There are more air conversion projects being considered through EnCana Corporation's Energy Efficiency Initiative. One pilot project located at Wilson creek to test the robustness of the proposed protocol reduces an estimated 697 tCO₂e/yr⁵.
- CAPP has indicated that projects are currently being evaluated for conversion.⁶

Several experts were consulted and indicated that air conversion projects exist within industry and have been implemented in the past. They stated that air conversion projects are not standard practice because of the costs involved in implementing them. Details to the projects they have participated in were not given and they also stated that significant opportunities exist for air conversion projects.

Conclusions

Based on the limited information, the following conclusions can be made about the projects encountered so far:

- Few projects have been implemented to date and consequently the reduction in emissions from these projects has a minimal impact given the enormous estimated amounts still vented (refer to section **B.1** for details on vented volumes);
- The conversion project targets relatively small facilities according to publicly reported data by the aforementioned companies;
- There is still a significant opportunity for emissions reduction with air conversions given the limited market penetration of this technology.
- Approval of this proposed protocol will stimulate air conversion projects

B.7. Summary of Quantification Approaches: *(Include a summary of GHG quantification approaches and methodologies. At a broad level, not exact formulae and emission factors, but where formulae will come from, activity data and emission factors, ie. Best Practice Guidance.)*

Review of existing protocols

There are no direct protocols/methodologies found that can be used to quantify emissions from conversion of gas to compressed air. Approved protocols from Carbon Offset Solutions will be used as models for this project quantification protocol. Protocols already approved that are linked to this protocol and other guidance documents that can facilitate the development of this protocol include:

² <http://www.ptac.org/eet/dl/eetf0401p04.pdf>

³ PennWest. Voluntary Challenge and Registry- Action Plan and Annual Progress Reports. Years 2000-2006

⁴ EnCana Corporation internal database

⁵ Preliminary information from start up project located at Wilson Creek

⁶ Phillips, Krista (July 15, 2008). Personal Communication. CAPP

- Landfill Gas Quantification Protocol from Alberta Carbon Offset Solutions-this protocol focuses on capturing vented gas for combustion
- Flare (or vent) reduction and utilization of gas from oil wells as a feedstock from UNFCCC- provides a similar solution conceptually to proposed protocol
- The GHG Protocol for Project Accounting from WRI and WBCSD- this document serves as a template of how to design a protocol
- New Approach to Control Valve Sizing, Sizing Valves for Gas Flow by L.R. Driskell-these documents contain formulas for gas flow that can adapted to the protocol
- ISO 14064-2 Standard from ISO- this guidance document standardizes protocol development into international standards
- ANSI/ISA-75.02-1996 Control Valve Capacity Test Procedures from ISA- this standard contains equations commonly used to establish pneumatic device parameters

Identification of sources and sinks

Greenhouse gas effects are changes in greenhouse gas emissions, removals, or storage caused by a project or activity. Effects can be classified as primary or secondary according to *The GHG Protocol for Project Accounting*. The primary effect of the project is to remove vented natural gas from the process control system. Secondary effects include greenhouse gas emission from electricity needed to compress and manage the air.

Process flow diagrams for both the baseline and project conditions were developed as a mechanism to identify sources and sinks using a Life Cycle Assessment (LCA). The results of this analysis identified the relevant sources and sinks that need to be quantified for this proposed protocol, which include:

- Volume of compressed air- This is the volume that will pass through the piping network and power the pneumatic control devices. This can be used to establish how much natural gas would have been vented as detailed in the Technical Seed Document (TSD).
- Volume of greenhouse gas emitted to compress and manage the air-This includes emissions from the production of electricity to run the compressor and form air management systems. The greenhouse gases should include those that are normally emitted such as CO₂, CH₄, and N₂O.
- Emission factors from fossil fuel extraction and processing in the project and baseline will come from credited sources.

Proposed protocol quantification approach

The general approach is to calculate the offsets as follows:

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Vented Fuel Gas}} + \text{Emissions}_{\text{Flared/Combusted Fuel Gas}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Air Compression}} + \text{Emissions}_{\text{Air Management System}}$$

where

Emissions_{Baseline} = sum of the emissions under the baseline condition.

<p>Emissions_{Fuel Extraction / Processing} = emissions from fuel extraction and processing of fuels used in the baseline</p> <p>Emissions_{Vented Fuel Gas} = emissions from vented fuel gas from pneumatic instruments</p> <p>Emissions_{Flared/Combusted Fuel Gas} = emissions from flared/combusted fuel gas from pneumatic instruments</p> <p>Emissions_{Project} = sum of the emissions under the project condition.</p> <p>Emissions_{Fuel Extraction / Processing} = emissions from fuel extraction and processing used in the project</p> <p>Emissions_{Air Compression} = emissions from compressing air</p> <p>Emissions_{Air Management System} = emissions from managing air</p>
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B.8. Other Impacts (Optional): *(Include other air emissions, odors, risks, environmental impacts on vegetation, wildlife, water resources etc.)*

No other emissions or odors, or risks and environmental impacts are expected for projects that undergo conversion from instrument gas to instrument air in process control systems.

No new infrastructure such as roads will need to be built. Air compression systems occupy small physical spaces and expected impacts will be minimal. For facilities with previously installed air compression equipment, impacts are expected to be minor as only slight changes to existing equipment will be required.

Quantification of the greenhouse gases and the offsets created through the proposed protocol should act to facilitate operations’ personnel engagement. This is due to the fact that the results of work can be quantified and that project economics will be improved as a result of implementing the proposed protocol.

Improve worker safety by eliminating methane emissions is a positive impact. Methane can affect respiratory system and oxygen uptake by hemoglobin causing nausea and dizziness, among other negative health effects in concealed environments. Additionally, fire hazard risks are reduced. Ambient methane vented from the control instruments in poorly ventilated areas can accumulate and if ignited, may create serious fire hazards. This project would eliminate this risk. Reduction in trace Volatile Organic Compounds (VOCs) which can cause cancer and contribute to ozone formation may occur. VOCs reduced by implementation of this project may have a positive impact on worker health and the environment.

Reduction in trace sulfur and carbon dioxide, contributors to acid rain and acidification is another positive impact. These gases are found in fuel gas in small quantities that are bled and vented. They form acids in the presence of water and acidify the environment. Acidification can lead to loss of tissue in vegetation when in contact. Acidification can also destroy masonry and raise pH levels of water bodies.

The improvement of energy efficiency is perhaps the most significant impact for the organization implementing this project.

B.9. Assessment of Baseline Scenarios
(Evaluate all possible Baseline Approaches in the list below, and identify which ones are appropriate for the Projected Protocol. Justify why each selected Baseline Scenarios is appropriate. Also justify why the other Baseline Scenarios are not appropriate and are excluded from the Protocol).

An assessment of potential baseline scenarios was performed based on section 2.5.2 Baseline Conditions from Alberta Carbon Offset Solutions’ “*Offset Credit Project Guidance Document*”. Preference was given to baseline candidates that portrayed accuracy and conservativeness. Baselines were also defined as either static or dynamic depending on the characteristics of each one. **TABLE B. 4** summarizes the baseline candidates and the reason they were accepted or rejected.

TABLE B. 4 Assessment of Possible Baseline Scenarios

1. Baseline Options	2. Description	3. Static / Dynamic Baseline	4. Accept or Reject and Justify
Historic Benchmark:	Natural gas vented from pneumatic instruments can be metered at each facility. <i>(Typically site-specific and can be constructed to reflect reductions in a base period (such as the average emissions of the previous three years).)</i>	Static/ Dynamic	Reject- It is standard practice in industry not to meter pneumatic devices, so establishing a historic baseline is not feasible.
Performance Standard:	Greenhouse gas emissions can be established by gathering data from facilities or using accepted emission factors. <i>(Assumes the typical emissions profile for the industry or sector is a reasonable representation of the baseline.)</i>	Static	Rejected- Although accepted emissions factors from CAPP or other sources are used for reporting vented gas from pneumatic instruments, a greater level of accuracy would be achieved through site-specific measurements and calculations.
Comparison-based:	Emissions can be taken from a control group and compared to the project. <i>(Actual measurements of parameters from a control group to compare with the project.)</i>	Static	Rejected-Metering is not a standard industry practice at facilities venting gas, so this baseline option is not practical. Additionally, emissions are very site-specific, so a comparison will not reveal a true picture of emissions even if a trend is apparent from the data collected. This is also the case if published manufacture instrument rates, as determined in a control group under laboratory conditions, are used. It was determined that site-specific measurements and calculations would provide greater accuracy (i.e. difficult to simulate how often a device may actuate in a lab).
Projection-Based:	Emissions can be used to project future emissions reductions using a gas equivalency technique. <i>(Projections of reductions in the future can use a variety of techniques, from simple straight-line growth assumptions to complex models.)</i>	Static/ Dynamic	Accepted-Air volumes are metered and then converted to gas using gas equivalency technique develop in the Technical Seed Document (TSD). Additionally, pneumatic instruments operate at a steady state, so the baseline will be considered static. It can also be considered dynamic if devices are added or decommissioned at the site as well as the inclusion of an annual gas composition analysis in the calculation of emission reductions.

Adjusted Baseline:	Emissions from an established baseline can be adjusted to reflect a baseline from another project <i>(Takes into account current practice levels of a particular project and specified that the same baseline is used for all projects of a certain type, regardless of historical practices.)</i>	Static/ Dynamic	Accepted-Emissions are site-specific and using this approach may be necessary if flexibility mechanisms are used. See section B.13 for details on flexibility mechanisms.
Other (Explain):		N/A	Rejected-No other baseline is available.

B.10. Selection of Baseline Scenario: *(For the selected baselines scenario(s) from the above analysis, the Protocol Developer must explain why the Baseline approach is static or dynamic, justify the selection of the most appropriate baseline scenario(s) including references and any assumptions.)*

A projection-based baseline was accepted. The TPP and the proposed protocol rely on metered quantities to establish baseline emissions using a gas equivalency formula. This formula and its development are explained in detail in the TSD. Pneumatic devices typically operate at a steady state and the devices are adjusted to handle constant volumes. This will translate into steady emissions from control devices; consequently a static baseline is accepted as well. An adjusted baseline may also apply in air conversion projects that justify the use of flexibility mechanisms as detailed in section **B.13**. These adjusted baselines will be dynamic because they will require the project proponent to decrease metered emissions.

It must be stated that baseline emission may be adjusted according to considerations explained in section **B.13 Flexibility Mechanism**. These will alter the baseline. Emission factors accepted for protocol implementation such as electricity displacement factors may undergo reviews in the future. These examples illustrate the fact that baseline emissions can vary. For this reason, a dynamic baseline is also possible and is accepted as well.

B.11. Definition of the Project Condition: *(Define the project condition and justification for the scope of the activity considered.)*

This proposed protocol is written for the gas and/or oil operator or any operator in the oil and gas industry where natural gas is used to provide pressure for process control applications. Some familiarity with, or understanding of, the operation of gas and/or oil operations and control systems is assumed.

Wells, oil producing and gas producing facilities, and gas processing facilities all use pneumatic devices for process control. Pneumatic instruments may be powered by compressed air, natural gas, or propane. Readily available pressurized natural gas has made it the power source of choice among operators in the industry. Natural gas is used to power process control equipment, which includes pressure controllers, temperature controllers, transducers, liquid level controllers, and flow rate regulators. These devices have one or two emission rates depending on the design: continuous or bleed rate and intermittent or vent rate. Once the gas has powered the instrument, it is left to vent and bleed to the atmosphere. The vent and bleed rate will depend on the type of device, age and operating condition. For the purpose of this protocol, the sum of these two emission rates will be referred to as **vent rate or vented gas**, which is the term commonly used in the oil and gas industry.

The opportunity for generating carbon offsets with this proposed protocol arises from the direct and indirect reduction of greenhouse gas emissions resulting from the conversion of natural gas pneumatic to instrument air for control instruments. Instrument air will be provided by compressed air. Therefore, a complete air compressor system will be needed for this conversion.

It must be stated that this proposed protocol does not stipulate a process change but rather a change in the pressure source for typical process control instruments. It is assumed that a natural gas pressure source will be converted to an air pressure source. It should be noted that any volume that would have been vented will now be avoided by this conversion. The final fate of the gas may be assumed to be combustion by end-users, unless otherwise indicated.

Protocol Scope and Description

This proposed protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring, and greenhouse gas quantification requirements for reductions resulting from conversion of natural gas pneumatic to instrument air in process control systems. Upon conversion, all methane that would have been vented will be replaced by compressed air. Emissions in the project stem from electricity consumption used to compress the air, and to manage and condition the air.

Protocol Approach

The baseline condition for this protocol is defined as the volume of natural gas vented or flared/combusted to the atmosphere prior to the conversion to the air system. In this baseline scenario, processed natural gas is used to supply fuel gas for facility processes. This gas is typically sourced from the fuel supply for the entire facility. This is a major source of greenhouse gas emissions for the baseline. Other sources of emission include greenhouse gases from fuel extraction and processing.

In the baseline condition, vented, or flared/combusted gas is typically not metered. Establishing volumes of vented, or flared/combusted gas will have to be performed by converting metered volumes of air to volumes of gas through an equivalency. This proposed protocol therefore uses data from metered air to establish the volume of natural gas that would have been vented, or flared/combusted had the project not taken place. Further explanation of how to establish this equivalency is detailed in the TSD. Establishing the amount of compressed air for the project will depend on the facility implementing the air conversion system. For facilities installing an air compressor system to power pneumatic instruments, metering air is straightforward. Metered air will provide volumes that can be used to establish emissions from:

- Equivalent fuel gas vented, or flared/combusted; and
- Emissions from fuel gas extraction and processing.

However, some facilities may have an air compressor system already installed for other applications. In such cases, air consumed by the pneumatic instruments will have to be prorated against total air compressed. In addition to the previously mentioned emissions, prorated air consumption can be applied to total electricity consumed to:

- Establish electricity used to compress air for pneumatic instruments; and
- Emissions from air management and conditioning;

Prorated quantities may also be reconciliated quantities on a periodic basis. In other words, a balance be carried out to determine the quantities used in air compression. Lastly, electricity consumption must also be metered to establish consumption and emissions.

Equations have been developed in order to quantify these emissions from the project and baseline conditions. These equations have been developed considering choked conditions in the pneumatic devices. This assumption yields equations that are accurate, yet underestimate emissions. This is a conservative approach and assures that emissions are not overestimated. In addition, this assumption makes the protocol easy to use and data collection simple and manageable. Refer to the TSD for more details.

Metering will be carried out for a minimum period of **ONE** month for all metered quantities. The project proponent should choose a month that is **representative** of normal operating conditions. Emissions from this period are assumed to be **representative** of normal instrument operations during the project and

baseline conditions and will represent a cap for the project's time span. This cap represents the maximum emissions that project proponent may claim, even if the facility increases operations and consequently its emissions from control instruments. Furthermore, since control instruments work at a steady rate in a given facility, this period of metering will reflect a static condition for both the baseline and the project for the reporting period. This protocol therefore assumes that the baseline and project condition are static. They may become dynamic if the baseline is adjusted for added or decommissioned devices as detailed in section **B.3 Flexibility Mechanisms**.

Protocol Applicability

To demonstrate that a project meets the requirements under this protocol, the project developer must supply sufficient evidence to demonstrate that:

1. Demonstrate functional equivalence between the instrument gas system and the instrument air system. The instrument air system will replace the instrument gas system in process control.
2. The key concept in this applicability criterion is for the project proponent to inspect and repair leaks prior to actual metering to reduce and mitigate risks associated with overestimation of emissions.

Prior to the implementation of the instrument air system and metering, the project proponent must demonstrate that the instrument air system's piping network has been inspected for leaks as pursuant to section 8.7 in Directive 60. This directive states that an operator of an oil or gas facility must develop and implement a program to detect and repair leaks meeting or exceeding the *CAPP Best Management Practice (BMP) for Fugitive Emissions Management*. This BMP suggests annual or quarterly leak monitoring frequencies depending on the process equipment device. Following these steps should guarantee that leaks have been minimized as much as practically possible. This will ensure that metering does not overestimate volumes of air, which in turn determines the volumes of gas that would have been vented, had the project not taken place. If inspection for leaks is not performed according to suggested monitoring frequencies, metered air must be reduced using a discount factor.

For projects installed prior to this protocol and are currently not metered, the same principle applies as detailed above. Prior to the installation of a metering system, leaks should be minimized as much as practically possible.

3. This protocol has been designed for specific use in natural gas processing plants. However, other facilities in the oil and gas industry use natural gas pneumatics to provide pressure. This protocol may be applied to projects where existing gas pneumatic provides pressure to instrumentation or Chemical Injection Pumps (CIP), or other types of equipment.
4. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System. [Of particular note:
 - a. [The date of equipment installation, operating parameter changes or process reconfiguration are initiated or have effect on the project on or after January 1, 202 as indicated by facility records;]
 - b. [The project may generate emission reduction offsets for a period of 8 years unless an extension is granted by Alberta Environment, as indicated by facility and offset records. Additional credit duration periods require a reassessment of the baseline condition; and,]
 - c. [Ownership of the emission reduction offsets must be established as indicated by facility records.]

B. 12. Functional Equivalence: *(Explain how the project and the baseline are comparable in terms of products and/or activity level. Justify any lack of equivalency.)*

The project and the baseline should provide the same function and quality of products or services. This type of comparison requires a common metric or unit of measurement for comparison between the project and baseline condition. Pressurized air will provide the same level of service as pressurized natural gas would have to the pneumatic instruments. This pressure will therefore characterize a volume which is expressed in m^3 of natural gas or air consumed by the pneumatic instruments. Over the reporting period, volumes will be the metric unit used to compare the baseline and the project. For reporting purposes, the volumes will be converted to mass units, i.e. tonnes of CO_2e , to calculate the offsets. In essence, the air consumed by the pneumatic devices can be used to establish the natural gas that would have been consumed. Functional equivalence comes in the form of consumed volumes as explained in the TSD.

B.13. Flexibility Mechanisms: *(Explain optional approaches for quantifying the reductions to be achieved from the project type.)*

The proposed protocol requires volumes of greenhouse gas emission to be accounted for in order to calculate the avoided greenhouse gas emissions. This may be accomplished by metering all sources of greenhouse gases. In cases where metering is limited the following flexibility mechanisms may be applied:

1. Site specific emissions factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust to ensure accuracy. As an example, the most probable source of energy to power the air system will be electrical. The most current electricity displacement factor for on-grid electricity in Alberta is .65 tonnes CO_2e/MWh ⁷. This value will be reviewed every three years by relevant authorities and if necessary recalculated and changed. If the operator is a self-generator, the EF can be calculated from the fuel source the project proponent is using.
2. Baseline and project metering may be carried out for more than one month if the project proponent deems necessary to show more accurate and representative emissions. It is up to the project proponent to justify this flexibility mechanism.
3. For cases in which projects were implemented but the air was not metered, carbon offsets are claimable. This claim is based on instrument counts from the facility and the metered air. Emissions from the one month metering are used as a baseline. This baseline is adjusted by subtracting the number of devices added to the facility during the previous unmetered period from the baseline. It is up to the project developer to use emission or bleed rates that are most current by contacting the manufacturer of specific devices and request information for those specific devices. Manufacturers of control devices usually publish the emission rates for each type of device, and for each type of operation.
4. For projects where part of the vented gas is flared or collected for combustion, the project proponent may claim credits using this protocol's flexibility mechanism. The total metered air is divided into two fractions; X represents the vented fraction and (1-X) represents the flared or combusted fraction. X represents a fraction that is established using vendor's technical specifications for bleed rates (BR).
5. If emissions are reduced because of decommissioning of devices, the metered baseline must be adjusted. Decommissioned devices would be subtracted from the baseline.
6. Instrument air conversions can be installed at single or multiple sites. As such, the protocol allows

⁷ This value can be referenced from "Offset Credit Project Guidance Document" (February, 2008) from Alberta Environment.

for flexibility in quantifying offsets from multiple conversion projects.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

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