3.2.3. **Instrument Gas to Instrument Air (IGIA) Conversion Projects for Pneumatic Control Systems**

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**Description**
Throughout the oil and gas industry, pressurized natural gas is used to operate pneumatic instruments and pumps in process control and chemical injection applications. Once the natural gas has run through the series of instruments or through a pump, it is vented to the atmosphere. The vented natural gas is primarily methane, a potent greenhouse gas (GHG) with a global warming potential (GWP) of 25 times that of carbon dioxide. In the process, natural gas that could have otherwise been directed to sales is lost.

Converting pneumatic equipment to run on instrument air (an “IGIA Project”) rather than instrument gas (pressurized natural gas or “fuel gas”) eliminates the venting of natural gas to the atmosphere. A small amount of electricity is required to run the air compressor, but the magnitude of the GHG emissions from this energy input are an order of magnitude smaller than the baseline methane emissions from operating the existing instrument gas system (e.g. typically <5% of baseline emissions).

A typical instrument air system includes an air compressor package housed in a skid-mounted building with electric-drive motors, control panel, air filters, dual regenerative heatless desiccant air dryers, and a wet air receiver that is used as a volume buffer. Often dual air compressors are used in a lead-lag configuration for redundancy and ease of maintenance. For larger gas compressor stations or gas processing plants, a representative air compressor package would be a dual Eagle “Rota Nova NK-60” rotary screw air compressor.\(^2\)

The air compressor package ties in to all air-consuming pneumatic devices at the oil and gas facility, and may require the installation of new piping or modification of existing piping to ensure safe and efficient operation.

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**Site Applicability**
IGIA sites require that sufficient electricity is available onsite to power the added electrical loads from the instrument air compressor, desiccant dryers, metering/communications equipment, and any added building lighting or electric heaters. Three-phase power is usually necessary to run an air compressor, so smaller sites with single-phase power will likely require electrical upgrades to accommodate the new instrument air package.

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Piping layout of the facility must also be assessed, as instrument air needs to be distributed to supply pneumatic equipment in each building and sometimes additional devices outside of the buildings, such as emergency shutdown valves (ESDV). If possible, these should use above ground pipe racks to minimize trenching and hydrovac costs, especially at older plant sites where there may be a lot of underground piping.

**Emissions Reduction and Energy Efficiency**

**Measurement:**
It is necessary to install measurement and data-collection equipment to generate verifiable carbon offsets from IGIA projects in Alberta. This requires continuous direct measurement with a dedicated flow meter installed downstream from the air compressor and air dryers. Meters are normally tied into a supervisory control and data acquisition (SCADA) system for continuous data collection, similar to conventional gas production meters. Data is collected every 15 minutes and averaged daily. Meters are typically calibrated annually.

**Baseline Emissions:**
Methane is vented to the atmosphere from dedicated vent lines associated with the operation of pneumatic instruments and pneumatic pumps. Flaring of instrument gas is not normally practiced for safety and operational reasons (e.g. to prevent backpressure on the instruments).

Under the Alberta Offset System (AOS) Quantification Protocol for Greenhouse Gas Emissions Reductions from Pneumatic Devices the baseline GHG emissions are calculated based on metered compressed air flow rates (after installation of air compressor package), a conversion factor called a gas equivalency factor, the site gas composition (% methane), the density of methane and the global warming potential of methane.

A simplified formula to estimate baseline emissions:
Baseline Emissions = (Estimated Natural Gas Savings in m³/year)*(% Methane in gas)*(Density of Methane)*(0.001 t/kg)*(GWP of Methane).4

Net GHG reduction calculations must include the incremental emissions associated with the electricity used to operate the air compressor (and any other incremental energy inputs).

Estimated GHG Emission Reductions:
GHG reductions from nine IGIA projects completed at compressor stations or small gas processing plants in Alberta ranged from approximately 400 to 8,500 tCO₂e/year per project, with an average of approximately 3,000 tCO₂e/year per project.

**Economic Analysis**

Capital Cost: Capital costs are highly site-specific, but costs from IGIA projects completed in Alberta at compressor stations and small gas processing plants have ranged from

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3 Refer to the AOS Protocol for the full calculation. [https://open.alberta.ca/publications/9781460131633](https://open.alberta.ca/publications/9781460131633)


Density of Methane gas at 15°C and 1atmosphere is 0.6797 kg CH₄/m³, per [https://encyclopedia.airliquide.com/methane](https://encyclopedia.airliquide.com/methane)
approximately $75,000 to $350,000. In these sample projects, power was already available at the site. The capital costs may be much higher for off-grid sites that need to add power generation equipment (gensets), bring in power lines to the site, or make other major upgrades to the site electrical infrastructure.

**Operating Cost:**
Operating costs stem from two main sources: The electricity used to run the air compressor, and maintenance of the air compressor and air dryers. For an air compressor that uses 10kW of power on average, the incremental electricity costs would be ~$8,700/year assuming an electricity cost of $0.10/kWh. Maintenance costs include compressor oil changes and servicing the air compressor(s) and dryers, and are estimated at between $2,000 and $5,000/year for a typical project. These costs may be partially or wholly offset by reduced maintenance on instruments if fuel gas previously contained significant impurities (wet gas, hydrocarbons etc.).

**Maintenance Cost:**
Maintenance cost savings can be achieved through switching to clean, dry compressed air, which helps avoid the need to repair instrumentation and controllers, especially if fuel gas quality is poor at the site. The costs of operating and servicing an air compressor may be less than the cost of replacing entire instrumentation loops due to wet gas destroying instrumentation.

**Carbon Offset Credits:**
The value of carbon offsets can be very significant for IGIA projects and, using an assumed carbon offset value of $25/offset in Alberta, would outweigh the value of the gas savings by a significant margin. Based on the GHG reductions achieved by the nine Alberta IGIA projects mentioned above (low of 400 tCO₂e to a high of 8,500 tCO₂e and an average of 3,000 tCO₂e), the value of the carbon offsets at $25/offset could be worth $10,000 on the low end; $212,500 on the high end; an average $75,000 per project per year.

**Payback, Return on Investment and Marginal Abatement Cost:**
Gas savings are the primary benefit from IGIA projects and will be very site specific. Gas savings from nine IGIA projects completed in Alberta ranged from approximately 2.5 mcf/d to 51 mcf/d, with the average at 18 mcf/d. At a flat $2.50/mcf AECO gas price, these gas savings would be worth from $2,300/yr (2.5 mcf/d) to $46,500/yr (50 mcf/d) or an average of $16,400/yr (18 mcf/d).

Overall Cost-Benefit: Generally, the larger the site, the better the economics, although other factors such as site layout/piping distances and proportion of high-bleed pneumatic devices will impact the economics. Although economics are very site specific, it is possible to achieve paybacks of <3 years if carbon offsets are generated. Most projects will be uneconomic without carbon offsets, unless the site suffers from high maintenance costs due to wet fuel gas.

**Barriers:**
• Financial barriers – low value of fuel gas makes many projects uneconomic, although carbon offsets can improve economics. Capital costs are high when retrofitting older facilities. Minimal capital available for energy efficiency or emission reduction projects;
• Inadequate electrical infrastructure to accommodate new loads from air compressor or no electrical connection to the grid;
• Difficulty estimating fuel gas usage associated with instrumentation loops (e.g. small volumes of fuel gas are used by instrumentation relative to larger fuel gas users like compressor engines;
• Unwillingness to modify proven facility designs that are reliable.

Reliability
Industrial instrument air systems provide high reliability, especially when designed with redundancy to use dual air compressors in a lead-lag configuration such that one air compressor can be serviced while the other unit is running. This approach also extends the lifespan of the air compressors as only one unit is running at a time. At sites where instrument gas quality is poor, the addition of an instrument air system can improve reliability and reduce maintenance of instrumentation.

If power outages are common, then it is wise to purchase a portable gasoline/diesel-powered air compressor that can be tied into a piping “t” to supply compressed air to the facility. This adds to cost, but avoiding production downtime will allow the incremental cost to be recovered quickly during upsets. Designing larger air storage buffer vessels is another tool to reduce risk of downtime. This is recommended if the facility’s engines are started using compressed air in pneumatic starters.

Safety
IGIA conversion project must ensure that all the pre-existing instrumentation tubing and fuel gas piping that previously distributed instrument gas to the pneumatic devices is carefully isolated from the new compressed air pipelines to avoid any chance of air and gas mixing to create an explosive environment.

Regulatory
Operators must obtain and comply with relevant facilities codes and regulations.

Future Regulatory Considerations:
Both the Alberta Government and the Federal Government have announced their intentions to regulate methane emissions from pneumatic controllers and pumps. Draft regulations are expected in 2017 with compliance requirements by 2020-2023 timeframe. It is expected that there will be specific limits on methane venting from pneumatic equipment and different standards for new (greenfield) facilities and potential requirements to retrofit existing pneumatic equipment.

IGIA projects can be an excellent solution to meet regulatory compliance by completely eliminating methane emissions from pneumatic equipment.

5 https://www.alberta.ca/climate-leadership-plan.aspx#toc-5
Service Provider/More Information on This Practice

References: