09-IAGT-101
An Alternative Approach to Continuous Compliance Monitoring and Turbine Plant Optimization using a PEMS

Quantifying emissions and complying with environmental regulations are important issues for gas turbine plants. These objectives can often be met with either a CEMS (Continuous Emission Monitoring System) using gas analyzers or a software only PEMS (Predictive Emissions Monitoring System). PEMS interface directly to the turbine control system and represent a lower cost alternative to traditional CEMS. PEMS are a compliance monitoring alternative consisting of a model of the turbine operations and its emissions. PEMS can be used to track plant combustion efficiency. PEMS can allow for more efficient operation of the plant because the PEMS system tracks excess emissions and can be used to determine the causes of and reduce pollution. This paper not only reviews the use of PEMS at three different turbine facilities and highlights the costs and benefits of using a PEMS for documenting emissions of priority pollutants and Green House Gases (GHG), but also in terms of overall plant efficiency, operator awareness and involvement, improvements in process control, waste and emission minimization, and in focusing the available manpower resources on core plant operating tasks as opposed to non-core analyzer systems.

09-IAGT-102
Shared Technologies and the Development of the Titan 250 Gas Turbine System
The Titan 250 gas turbine, 22.4 kW (30,000 HP), and scaled C85 pipeline gas compressor, are the latest additions to the Solar product family. These new products leverage core technologies that have been developed and proven in several other well-established products. The use of shared and proven technologies, helps reduce early-hour operational risk when introducing new turbomachinery products. The Titan 250 gas turbine is a conservative hybrid design grounded in advanced aerodynamic, thermal and mechanical design tools and methodologies, with thorough combustion system testing, proven materials and hot section cooling experience at the same firing temperature. These technologies have been validated through full-scale laboratory and field-testing and extensive operating experience. The C85 gas compressor is another aerodynamic-scaled model from the durable Solar gas transmission product family.

The Titan 250 gas turbine is ISO rated at 22.4 kW (30,000 HP), with a best in class shaft efficiency of 40%, reducing fuel costs and emissions. The engine is a two-shaft design that includes a 16-stage axial-flow compressor (PR 24:1), a dry low emissions combustor (<15 ppmv NO_x), a two-stage gas producer turbine operating at a firing temperature of 1204°C (2200ºF), and a three-stage, all-shrouded blade power turbine to maximize efficiency.

09-IAGT-103
LMS100® Advancements in Flexible Power Generation and Development of Dry Low Emissions (DLE) Capability
The profile of the energy industry is changing to meet the increasing demands for efficient and flexible products that can be integrated to the various grid systems. Having now installed several additional LMS100® units into various countries, a broader understanding on the benefits that the hybrid, inter-cooled gas turbine brings is being demonstrated for several operators. The application of the 100MWe product into both cyclic and baseload applications has provided the team an opportunity to identify and improve several key systems to further enhance the existing

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system for both 50 and 60Hz applications. As the fleet adds both units and hours, another significant product is being brought to market – the Dry Low Emissions (DLE) combustion alternative. This paper will detail several recently commissioned projects and highlight the technical and commercial aspects that led to the use of the LMS100 gas turbine. Product enhancements and application details will show the breadth of flexibility afforded to owners of the inter-cooled Aeroderivative technology in applications ranging from wind balancing to desalination to Oil and Gas. The technical details on the DLE system capabilities and design will provide the participants a thorough understanding on the programs final testing validation and readiness for market entry.

09-IAGT-104
Modern Test Facilities for Gas Turbine Engines: Requirements and Challenges
Modern Test Facilities allow R&TD teams to test Gas Turbine components with a wide variety of air and fuel parameters. To determine the suitability of the Test Facilities for operation with required fuel and air streams, various physical parameters need to be considered: pressure, temperature, dew point, mass flows, fuel composition, and others. The availability and reliability of the Test Facility's components are the important issues management and operators have to deal on the daily basis. This paper describes current approach the Gas Turbine Laboratory National Facilities is undertaking to provide a reliable support for R&TD activities. Special focus is given to the problem of facilities maintenance in the multi-client environment and reliability of operations. Suggestions on the type of maintenance, such as CBM and RCM, and tools for tracking the component life and performance, as well as operation scheduling are made.

09-IAGT-105
Compressor Station Noise Mapping
This paper presents results of multiple-point spectral noise measurements at three of TransCanada's compressor stations on the Alberta System. A method is described to determine the overall noise map of the station yard using Delaunay Triangulation and Natural-Neighbour Interpolation techniques. The results are presented in OSPL maps, as well as animated pictures of the sound pressure level (SPL) in frequency domain which will be shown on a video at the conference. The latter will be useful in future work to determine the culprit sources and the respective dominant frequency range that contributes the most to the overall OSPL.

09-IAGT-106
GT Power Generation Stations in Noise Sensitive Areas
One of the considerations in site selection of a GT power generating station is the potential adverse impact on off-property points of reception. As the project must comply with applicable noise guidelines and noise limits, it is important to establish the cost of noise control during the preliminary design stage. Noise controls are required whenever predicted noise exceeds allowable levels. A simplistic estimate based on overall sound power level is not sufficient as it fails to identify those sources that will require noise controls. A more detailed emission model is needed. These are easily generated with the aid of acoustic modeling software. The ubiquitous point sources are replaced with line and area sources. The result is a more precise distribution and description of the source region, as well as the resultant sound field.

The methodology will be illustrated by two case studies. The first describes a preliminary design for a peaking station in a rural area. Here the cost of noise controls is compared to the cost of purchasing the properties of the closest points of reception. The other is a retro-fit of an existing station in a suburban setting. Here the extremely stringent noise criterion of 27 dBA at 100m had to be met. In both cases detailed modeling of the sources, structures and terrain provide a realistic image of the sound fields.

09-IAGT-201

Cogeneration Flexibility for Steam Management

Refineries are large steam consumers. Steam is used as part of the refining process, as motive energy for turning rotating equipment and even as a source of heat for freeze protection. Steam production equipment is an integral part of this industry. Cogeneration has allowed refineries to have a cheaper source of steam and electricity and also provide revenue by selling any excess power to the local municipal grid. Well designed cogeneration plants have the flexibility to continue to provide steam and power even in abnormal circumstances such as plant upsets and power interruptions. Having a cogeneration system part of the facility increases plant reliability for supplying steam and power as well as providing affordable, clean energy to the plant and the community.

09-IAGT-202

Seimens Energy, Inc.'s Development for the Advanced SGT6-5000F

The SGT6-5000F engine has demonstrated an exceptional operational record over a 15-year, 4.7+ million fleet hour history. Since its introduction in 1993, this F-Class gas turbine has undergone continuous development to improve performance, reliability and operational flexibility and to reduce emissions and life cycle costs. The result is a gas turbine with an excellent operational record and customer value. In 2008, Siemens Energy started production of the latest upgraded version of the SGT6-5000F. The capabilities of this newest offering include a dual-fuel gas turbine which can deliver 150MW of power to the grid within 10 minutes, Ultra Low NOx combustion system (9ppm) and hot gas path components designed for extended maintenance intervals. This paper describes the technological advances now available in the SGT6-5000F gas turbine which will further improve performance, reliability, operational flexibility and customer value.

09-IAGT-203

Gasification of Low Value Refinery and Uprader Stream to High Value Products

Refining of petroleum or upgrading bitumen produces low value streams, such as petroleum coke and liquid residues, which are difficult to sell and process and pose environmental issues. Commercially proven gasification and ancillary technologies can process and convert these low value materials to high value products including hydrogen, diesel fuel, SNG, chemicals and power in an environmentally pristine manner. Assuming Alberta’s growth in heavy oil processing/upgrading continues, the demand for natural gas will be enormous and amazingly could outstrip local supply. Gasification is an alternative for preserving natural gas. Fundamentals of gasification, state of the technology, processing options and routes will be discussed.

09-IAGT-204

Application of the Latest GE Aeroderivative Gas Turbines (LM6000)

The LM6000 aeroderivative gas turbine unit at GE Energy has a 17-year history of continuously developing innovative products to help meet customer’s needs. Over the course of the past few years, GE Energy has accelerated technology improvements into the product line as well as applications for the LM6000. The flexibility of our latest DLE offering provides a simple cycle ‘throttle push’ to the highest combined cycle efficiency in its class. The introduction of the LM6000PG gas turbine provides 10%+ more power with the same size gas turbine. The 130 MWe 2x1 LM6000 PG has been designed for customers seeking fast, flexible and efficient combined cycle power generation. Through gas turbine and package improvements, the LM6000 continues evolve as a global leader in installations in the 35-65 MWe range, including several recent projects across Canada. Although each application is serving a different customer, each solution has been developed in close collaboration with industry leaders to ensure the needs of the operator and system are best met.

09-IAGT-205

Cooling of Gas Turbine Exhaust for Combined Cycle and Simple Cycle Applications

Industrial gas turbine exhaust temperatures regularly exceed 538 C (1000 F) during part and base load operation. In combined cycle applications with heat recovery steam generators or simple cycle applications with CO and NOx reduction equipment, the maximum gas temperature must be controlled to maintain equipment integrity and/or maximize emission reduction efficiency. In addition, careful control over the exhaust temperature is needed to prevent overcooling resulting in exposure of the SCR and stack components to dew point deposition.

Various methods can be used to control the gas turbine exhaust temperature. One method of cooling gas turbine exhaust is air injection. This involves the controlled introduction of ambient air into the exhaust duct to uniformly reduce temperatures at the HRSG/SCR. However, certain GT exhaust phenomena, such as turbine swirl and back pressure limitations, must be considered in order to optimize temperature control and steady-state CT performance.

A case study involving a GE Frame 6FA turbine will be used as an example to describe in the steps required to ensure a uniform temperature profile after air injection. This will encompass CFD modelling, ducting design and equipment selection.

09-IAGT-206

Waste Heat Recovery from Existing Simple Cycle Gas Turbine Plants - A Case Study

Waste heat recovery from the exhaust of existing simple cycle gas turbine plants is effective for powering new sources of electric generation without new sources of greenhouse gas emissions. This paper discusses two such projects in British Columbia, Canada. Discussed are the project conception, technology selection, regulatory considerations, and initial operation of these plants. Two 4.5 MW Enpower Green Energy Generation Limited Partnership plants are operating adjacent to Spectra Energy Corporation's natural gas transmission compression facilities at 150 Mile House, BC and Savona, BC. These plants are powered by the gas turbine exhaust heat of previously installed 18.5 MW ISO rated pipeline compressor drives taking an original simple cycle ISO thermal efficiency from 33.8% to a combined cycle thermal efficiency of 42.2%.

09-IAGT-301
Progress on Some Non-Intrusive Monitoring Technologies for Gas Turbine Operators

Diagnostics for high value gas turbine machinery can benefit from new and evolving sensor technologies. Test cells and ground–based installations are important technology demonstration targets for applications to benefit operators. Practical applications are sought in the work reported employing non-intrusive sensors that can be installed readily on working gas turbines as part of the installation and not engine-mounted. Current capabilities and results are discussed for infrared, audio and electrostatic sensors with baseline and fault implanted engine tests. Evolving work on spectroscopic methods is shown because of the significant benefit of identifying specific components and failure or degradation modes. Opportunities for the user and technology communities are discussed as part of the planned work.

09-IAGT-302
Union Gas Storage and Transmission Operations Bright Station Retrofit

In 2008, Union embarked on an unprecedented expansion project at the Bright Compressor Station. Unlike traditional expansion projects that have been built on 'greenfield' sites, this project consisted of replacing the two existing Rolls-Royce Avon compressor packages with larger Rolls-Royce RB211-DLE packages, all within the existing building footprints.

Specifically, the details of expansion project include:

- 4000 m of pipe installation;
- 23,000 diameter inches of pipe welds;
- 60,000m of power and communication cable laid;
- Replace Avon 1533/1534 packages c/w RT-48 Power Turbines with (2) packaged Rolls Royce RB211-24G-DLE units c/w RT-62 Power Turbines; acoustic enclosures, air inlet filters and exhaust stacks;
- Re-aero all 3 compressors to provide increased head and accommodate for parallel operation of all (3) units;
- Installation of 10 fan, 72 MBTUH aerial gas after cooler, to prepare the plant for future summer operations;
- Installation of one 500 kW auxiliary power generator to provide additional back-up power necessary to support the new aftercooler and gas generator systems.

The final commissioning of the plant was completed in early 2009. Essentially, the project increased the overall net compression/output power of the station by over 54,000 hp.

09-IAGT-303
The Role of Metallurgical Analysis in Gas Turbine Engine Maintenance

Metallurgical analysis characterizing component degradation can be used to assess the reparability of the components, identify abnormal or detrimental engine operating conditions and define the potential for service interval extension. The following paper summarizes the role of metallurgical analysis in managing the operation and maintenance of turbine blades to reduce costs and improve reliability. The implications of degradation modes including material degradation, coating degradation, hot corrosion, foreign object damage and damage within the internal passages on maintenance management will be discussed.

09-IAGT-304
Performance Upgrade of Siemens SGT-700 Gas Turbine for More Power and Higher Efficiency
Siemens SGT-700 was launched 10 years ago to the market at 30 MW, several units are now in commercial operation. The SGT-700 is an industrial gas turbine for mechanical drive applications. It is designed for heavy-duty operation under tough conditions, both onshore and offshore, floating or fixed, in hot or cold climates. SGT-700 is derived from the 25 MW SGT-600 and utilizing technology from the 47 MW SGT-800. The SGT-700 was from the beginning designed for plus 30 MW but introductory rating was set to 30 MW. Now with five units above 24 000 hours of experience together with the extensive testing it is time to release higher power and efficiency. This paper will discuss how the improved performance has been reached with minor improvements of the design. The paper will also describe the operation experience and the follow up of the fleet which is a very important factor in the higher rating. In the paper there will also be description of the test of the first unit with the improved performance. DLE performance and fuel flexibility will also be discussed. When fuel prices are going up there comes a market requirement to be able to burn gases with lower wobbe index and since environmental aspects are becoming more important it is necessary to be able to burn these fuel in a DLE mode. Flexible maintenance is important for high demanding customer and the several options for maintenance will be shown.

09-IAGT-305
Life Extension of Siemens Industrial sized Gas Turbines
Gas turbines are typically designed for a service life of 100 000 – 160 000 hours of operation, or 12 – 20 years of operation under worst case or near-worst case conditions regarding operation conditions, while assuming that specifications regarding environmental conditions, maintenance procedures, washing and fuel quality are fulfilled. In practice most gas turbine are only operated at design conditions for a fraction of their service time, indicating that operation life can almost always be extended. However due to a multitude of reasons specifications regarding fuel quality, maintenance procedures, washing and especially environmental conditions can be difficult to fulfill. Therefore, in order to maintain equipment safety, while life can often be extended, theoretical analyses and special inspections are required to determine which parts that need replacement to allow extension, and for how long life can safely be extended. Examples will be given from life extension of Siemens industrial-sized gas turbines.

09-IAGT-306
Harmattan Compressor Replacement
In 2008, Altagas installed a gas turbine/compressor set at the Harmattan gas plant to capture benefits related to efficiency improvement and emissions reduction. This paper will outline how existing reciprocating engine drive compressors were economically replaced by a new turbine drive centrifugal compressor with back-end waste heat recovery. The two major economic benefits to Altagas are reduced maintenance costs over time and fuel gas savings due to waste heat recovery. A significant NOx and CO_2 emission reduction was also realized with the turbine installation. Overall, the paper will walk through the major project objectives, decisions and challenges encountered to bring this combined heat and power project to fruition from an end user perspective.