REMVue® SlipStream® GTS-CHOPS Development Project

PTAC Report

Revision 2

February 22, 2016

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EXECUTIVE SUMMARY

Vented hydrocarbon emissions, primarily composed of methane gas, from the casing vent of Cold Heavy Oil Production with Sand (CHOPS) facilities are a major contributor of greenhouse gas emissions in Alberta and Saskatchewan's oil and gas industries. The release of these hydrocarbon emissions from CHOPS facilities also represent a significant loss of a potential clean energy source.

Where it is economically viable to do so, provincial regulations require that the casing vent gas is conserved. In many instances however, the physical isolation of CHOPS sites from existing pipeline or power distribution infrastructure makes conservation uneconomical and the casing vent gas is vented to atmosphere or flared.

The present development project, sponsored by Petroleum Technology Alliance of Canada, examined the possibility of applying REM Technology Inc.'s patent pending SlipStream GTS technology to gaseous fueled oil storage tank heaters at CHOPS facilities in order to maximize the use of the casing vent gas and reduce site greenhouse gas emissions.

After establishing the functional, performance, compliance and market requirements for the CHOPS application, developers set about identifying and mitigating key technical risks before proceeding with the design of a functional prototype. Detailed design documentation, a process hazards analysis, and internal design review were completed in preparation for fabricating a prototype for functional and performance testing.

Analysis of the system costs based on the prototype design suggested that although the application of the SlipStream GTS technology to the oil storage tank heaters was technically feasible, the cost of implementing the technology was too high for market acceptance. Based on this result, it was decided not to pursue development of a prototype at this time.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Purpose

This report contains a summary of the development work, partially funded through Petroleum Technology Alliance of Canada (PTAC), for the application of REM Technology Inc.'s (RTI) REMVue SlipStream GTS technology to gaseous fueled oil storage tank heaters at Cold Heavy Oil Production with Sand (CHOPS) facilities.

The initial work scope called for the design and evaluation of a pre-production SlipStream GTS prototype that could be used to collect and combust vented hydrocarbon emissions from the casing vent at CHOPS facilities. Upon completion of the initial prototype design it was determined that a viable SlipStream GTS solution that met all of the desired functional and performance criteria was uneconomical and the development project was concluded prior to prototype construction.

The following report provides details on:

- Project background
- SlipStream GTS and CHOPS technology
- System design requirements
- Design process and work completed

1.2 Intended Audience

This document is intended for public use and distribution. Expectations are that the readers of this document are familiar with CHOPS operations and the regulations for these facilities in Alberta and Saskatchewan.

1.3 Terms and Abbreviations

Table 1: Terms and Abbreviations

Abbreviation	Description
ABSA	Alberta Boilers Safety Association
AER	Alberta Energy Regulator
CHOPS	Cold Heavy Oil Production with Sand
BMS	Burner Management System

Abbreviation	**Description**
CSA	Canadian Standards Association
CVG	Casing Vent Gas
GOR	Gas to oil ratio
GPU	Gas Processing Unit
GTS	Green Tank System
PTAC	Petroleum Technology Alliance of Canada
RTI	REM Technology Inc.

2 BACKGROUND

2.1 CHOPS

In Alberta and Saskatchewan numerous companies are in involved in Cold Heavy Oil Production with Sand (CHOPS). A typical well site includes a wellhead, storage tank, and a small doghouse containing a natural gas engine and hydraulic pump, see Figure 1 and Figure 2. The function of the engine is to drive the hydraulic system, which drives a pump to extract the oil from the well and pump it into the adjacent storage tank. The engine also provides site power and is the source of heat for glycol heat tracing.

Agitation of the heavy oil in the formation during the production process results in the liberation of methane gas. This gas, collected from the well casing, is used as the primary fuel source for the engine and storage tank burner that heats the heavy oil. Any unused casing vent gas (CVG) is typically vented to atmosphere. In the event that there is insufficient CVG available, the engine and storage tank burner switches to a customer supplied propane source.

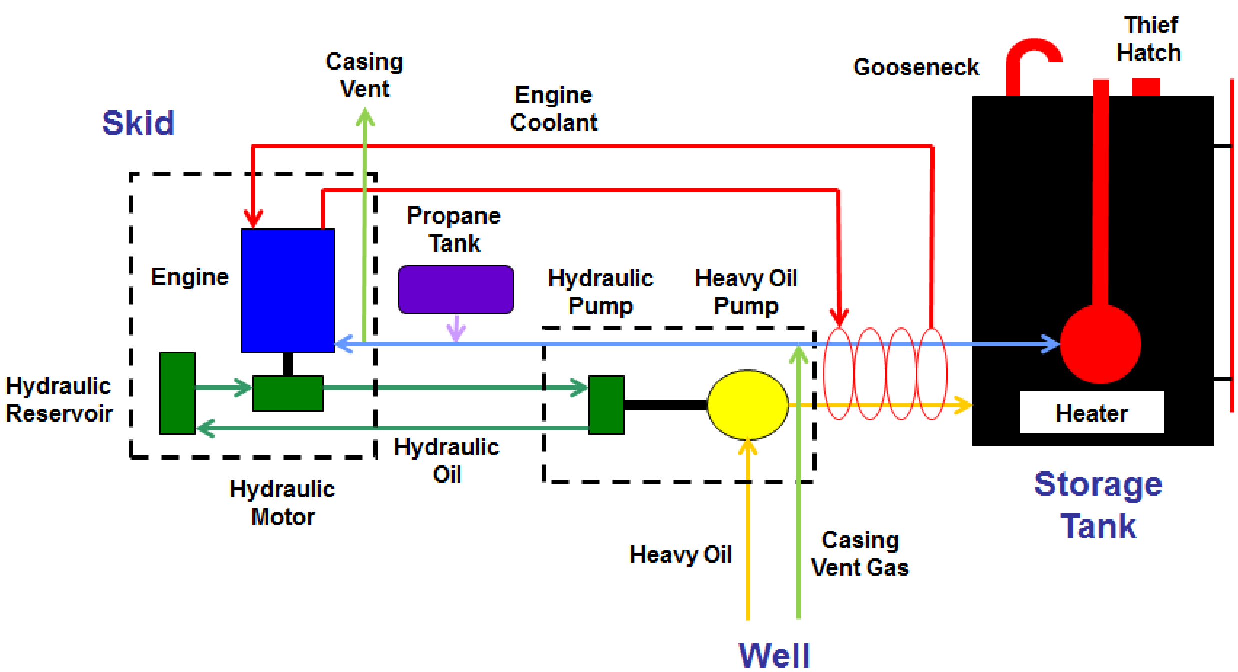

Figure 1: CHOPS Well Site Schematic

Figure 2: Typical CHOPS Site Installation

The emissions from these sites are a major contributor to the overall oil and gas industries' greenhouse gas emissions profile. The Alberta Energy Regulator (AER) identifies over 11,500 crude oil and bitumen sites in Alberta that are currently reporting vented or flared gas emissions. Requirements for flaring, incinerating and venting in Alberta's upstream petroleum industry, including CHOPS facilities, are provided in AER Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting (Alberta Energy Regulator, 2014).

Directive 060 requires that the gas that is separated from the oil during production, i.e: casing vent gas or solution gas, is conserved, i.e: recovered as an energy source or used for another beneficial purpose, if:

1. The gas volume is greater than 900 m^3/day per site and the conservation opportunity is deemed economic based on specific economic criteria

2. The gas to oil ratio (GOR) is greater than 3000 m^3/m^3

3. A flare or incinerator is within 500 m of a residence and the gas volume exceeds 900 m^3/day

4. The AER requests that the gas is conserved

Where solution gas conservation is not required by Directive 060 and vented gas volumes do not exceed 500 m^3/day, the Quantification Protocol for Solution Gas Conservation (Alberta Environment, 2012), approved under the Specified Gas Emitters Regulation in Alberta, provides a mechanism to generate greenhouse gas offsets if the vented gas is combusted.

Figure 3 shows vent rate statistics generated from the AER's ST60: Crude Oil & Crude Bitumen Batteries Monthly Flaring, Venting, & Production Data for August of 2014 (Alberta Energy Regulator, 2014). The data reveals that the majority of CHOPS wells vent less than 900 m^3/day and of these, the vast majority of wells vent less than 500 m^3/day.

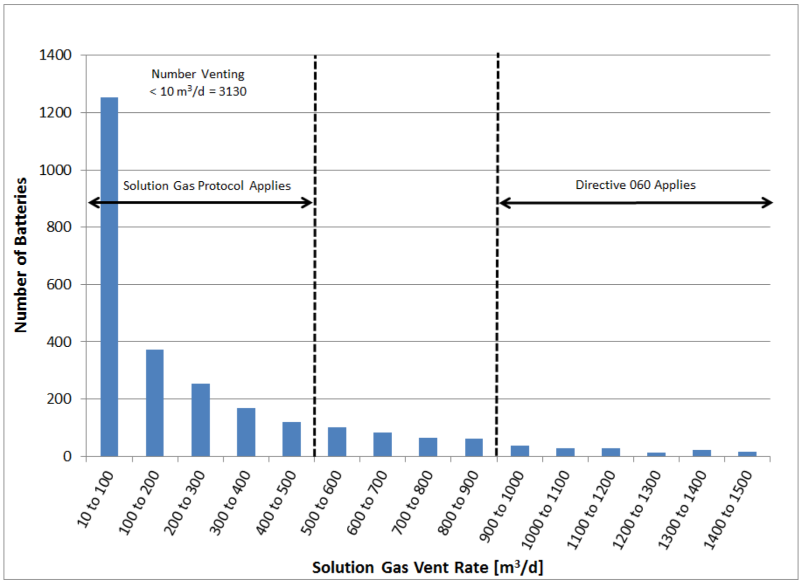

Figure 3: CHOPS Solution Gas Vent Rate Statistics

Expectations are that the AER will apply more stringent emissions requirements in the years to come, forcing owners / operators to further reduce their emissions at CHOPS facilities.

2.2 SlipStream GTS

REM Technology Inc. has developed a patent pending technology, the SlipStream® GTS, which allows for the safe destruction of hydrocarbon vented gases in a natural gas burner. In the SlipStream GTS system, the hydrocarbon vented gases serve as a supplemental fuel source, displacing a portion of the main process fuel and reducing burner fuel costs.

During periods where the main process burner is not in use, an auxiliary burner, located in the exhaust stack of the process burner, ensures the combustion of the vented hydrocarbon gas. The combustion of these hydrocarbon vapours, whether in the main process or auxiliary burner, reduces greenhouse gas emissions.

Figure 4 shows the basic system layout for a SlipStream GTS system as applied to a gas processing unit (GPU). The function of the GPU is to maintain the gas extracted from the well above the gas dew point to prevent freeze-off and to remove liquids from the extracted gas.

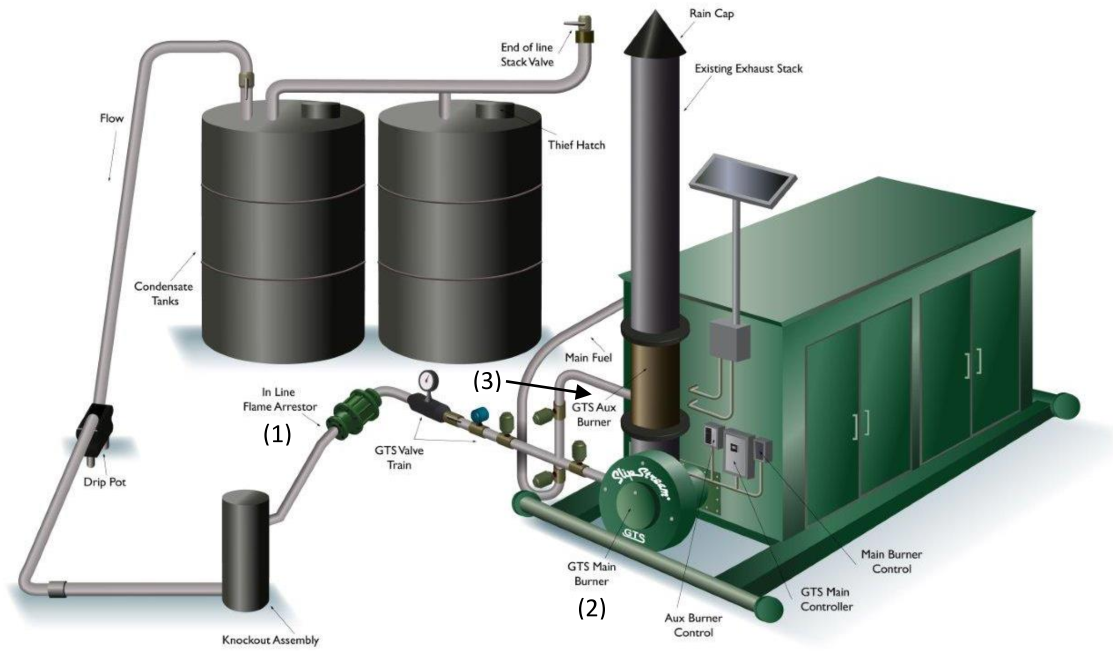

Figure 4: SlipStream GTS GPU Application Schematic

In the GPU application, gases evolved from the condensate collected in the storage tanks are routed through a drip pot, knockout assembly, and coalescer to remove as much liquids as possible from the gas stream. A thief hatch and end-of-line relief valve provide high and low pressure protection on the tanks.

A flame arrestor (1) in the low pressure gas line ensures that a flame cannot propagate from the burner back to the tanks. From the flame arrestor, the gases flow through the GTS valve train to the main process and auxiliary burners. The main process burner (2) provides process heat for the GPU and includes the air inlet flame arrestor, fire tube, and exhaust stack.

The auxiliary burner spool piece (3) is a section of exhaust pipe that is inserted in the existing exhaust stack. This pipe contains the auxiliary burner pilot and auxiliary burner.

Figure 5 provides a schematic representation of the basic SlipStream GTS control strategy. When there is a call for process heat, the GTS system turns on the pilot for the process burner. Based on the availability of vent gas, i.e. sufficient pressure is detected; the GTS system routes vent gas or process gas to the process burner.

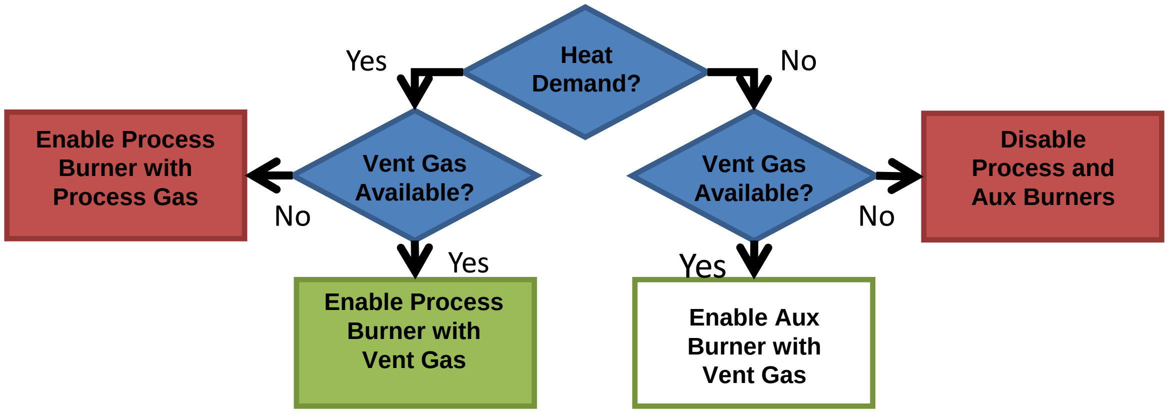

Figure 5: SlipStream GTS Basic Control Strategy

If there is no call for process heat and vent gas is available, the GTS system turns off the main process burner, turns on the pilot for the auxiliary burner, and routes the vent gas to the auxiliary burner for destruction.

2.3 Proposed Product Development

The objective of the SlipStream GTS-CHOPS project is to develop a version of the SlipStream GTS technology for CHOPS applications in Alberta and Saskatchewan. This new product shall provide for the safe collection and control of CVG at near atmospheric pressures to the existing oil storage tank heater or a new SlipStream GTS auxiliary burner located in the exhaust stack, see Figure 6. The product shall be able to seamlessly transition the main burner from operation on CVG to propane, depending on the availability of the CVG. To address the issues of line freeze off during cold weather, the integration of a heat recovery process is also proposed.

The anticipated benefits of implementing the SlipStream GTS technology on a CHOPS well site include:

- Elimination of vented hydrocarbon emissions from the casing vent
- Improved winter operation due to a reduction in freeze off issues
- Improved capacity to handle changes in gas vent gas composition and to optimize site propane usage
- Opportunity to upgrade existing burner equipment to be CSA 149.3-15 compliant
- Opportunity to qualify for greenhouse gas offsets under the Quantification Protocol for Solution Gas Conservation

- Opportunity to reduce vented emissions at marginal sites, i.e.: sites with vent volumes just about 900 m^3/day, to below the regulatory limit for conservation

- Additional site power and power back capabilities

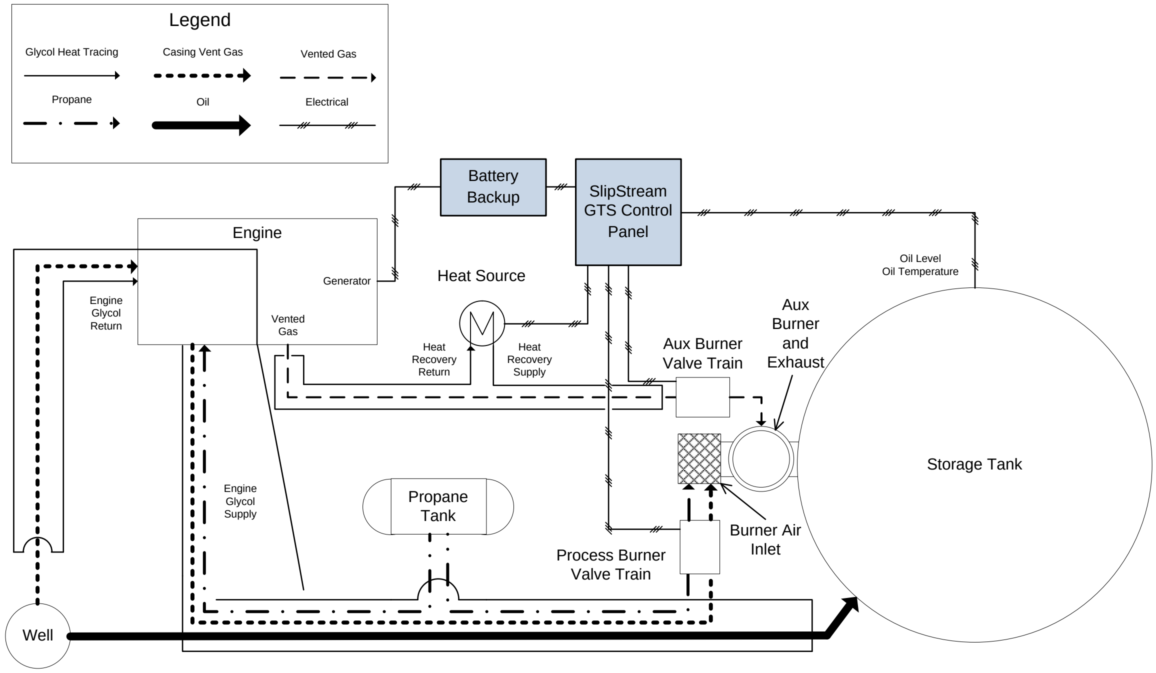

Figure 6: Basic SlipStream GTS-CHOPS Layout

For this project the GTS design is for a "typical" CHOPS implementation which consists of:

- A single well with a 1,000 barrel oil storage tank and 8" oil storage heater rated up to 300 Mbtu/hr
- A sweet casing vent gas source of up to 500 m^3/day that contains 85 – 100 % methane
- A single gas powered reciprocating engine (40 – 80 hp)
- A backup propane fuel source

The scope of work for the project includes:

- Scope definition and design constraints - *<u>Completed</u>*
    - Scope description
    - Funding requirements and restrictions
    - Acceptance criteria
    - Project charter

- Conceptual evaluation - *Completed*
    - Project kickoff
    - Project risk assessment and evaluation (testing and analysis)
    - Prototype design description and design approval
- Prototype design - *Completed*
    - Prototype engineering, hardware requirements and specification
    - Mechanical drawings, P&ID drawings, panel drawings, and bill of materials
    - Software control narrative, I/O list, and shutdown key
    - Internal "what if" hazards analysis and design review
    - Product cost analysis – Project stopped
- Prototype fabrication
    - Hardware procurement and fabrication
    - Software design, creation and factory acceptance test
- Prototype evaluation
    - Software and hardware functional test documentation
    - Hardware assembly and field test apparatus installation
    - Prototype testing and modifications
    - Internal interim performance report
- Prototype design updates
    - Prototype re-engineering, hardware requirements and specification
    - Drawing and bill of materials updates
    - Software control narrative, I/O list, and shutdown key updates
    - Customer hazards analysis and design review
    - Hardware procurement and fabrication
    - Software updates and factory acceptance test
- Final Report
    - Hardware assembly and field test apparatus installation
    - Prototype testing
    - PTAC final project report
    - Project close-out

The project deliverables include:

- Functional production prototype unit at the RTI test facility (RTI intellectual property)
- Generation of generic P&ID / PFD, layout and assembly drawings for a production unit (RTI intellectual property)
- Generation of generic I/O list, bill of materials, component datasheets, and pricing for a production unit (RTI intellectual property)
- Final project report (PTAC) which includes:
    - Description of the CHOPS technology and opportunity
    - Description of the GTS technology and basic system operation
    - Steady state and dynamic performance results under typical operating conditions
    - Implementation requirements and cost estimate
    - Summary of technology benefits / future work

3 DESIGN REQUIREMENTS

3.1 Components

The design of the SlipStream GTS-CHOPS system shall include the following core components:

- Basic liquids handling
- Low pressure main burner valve train and control
- High pressure main burner valve train and control
- Low pressure auxiliary burner valve train and control
- Auxiliary burner spool piece and exhaust stack
- Heat recovery hardware and control
- Supervisory control panel and burner management safety control
- Vent gas flow measurement
- Basic diagnostics and logging

3.2 Functional

The functional requirements for the SlipStream GTS-CHOPS systems are as follows:

- The control will utilize the feedback from a pressure transmitter in the vent gas supply and the heat request state of the main process burner to operate the main process and auxiliary burners.
- The control shall provide for automated switching between CVG and propane for the main process burner, based on the availability of CVG. The control must be able to handle rapid changes in the CVG flow rate within the burner's heat rate range.
- The system must be able to operate the main process and auxiliary burners simultaneously without any undesirable effects on system performance and reliability. This includes being able to safely handle the elevated stack exhaust and surface temperatures, as well as ensuring that the additional heat generated does not damage existing equipment.
- Burner safety control shall be provided by one or more burner management system(s) certified to meet the requirements of CSA B149.3 - Code for the Field Approval of Fuel-Related Components on Appliances and Equipment.
- The system shall be designed to fail safe. This includes a provision for a fail-safe method to vent the CVG to atmosphere in case of burner shutdown, over-pressure event, or line freeze-off.
- The heat recovery system will be designed to extract heat from a suitable source and provide this heat to a glycol heat loop. The primary purpose of this heat loop is to prevent

freezing of the fuel supply lines to the burners. A means of safely controlling the heat recovery systems' temperature, pressure and/or flow is required.

- The solution shall operate using 24 VDC power and without instrument gas. Provision for standby power for the supervisory control and BMS shall be considered.

3.3 Performance

The performance requirements for the SlipStream GTS-CHOPS systems are as follows:

- No visible emissions (black smoke)
- Maximum main burner heat rate of 300 Mbtu/hr
- Maximum auxiliary burner heat rate of 750 Mbtu/hr
- Minimum casing vent gas source pressure of 7 kPa (16 oz/in^2)
- Industrial weather proof design, ambient temperature range -40°C to 40°C

3.4 Safety / Compliance

The compliance requirements for the SlipStream GTS-CHOPS systems are as follows:

- The system shall be designed to meet the requirements of CSA B149.3 - Code for the Field Approval of Fuel-Related Components on Appliances and Equipment.
- The system shall be designed so that all devices located in the designated hazardous area meet CSA Class 1 Division 2 requirements (Tank area) or CSA General Purpose (Engine area).
- The system shall be designed to meet ABSA's boiler, pressure vessel, and pressure piping requirements, if applicable.

3.5 Cost

The economic requirements for the SlipStream GTS-CHOPS systems are as follows:

- The target production unit hardware to the customer shall not exceed $70,000 CDN.
- The target production unit install cost to the customer shall not exceed $25,000 CDN.

4 CONCEPTUAL EVALUATION

A number of technical challenges were identified based on the functional and performance requirements for the SlipStream GTS-CHOPS system. A series of theoretical and/or experimental studies were carried out to evaluate and address each risk prior to proceeding with any design work.

4.1 Casing Vent Gas Flow Variability

Field measurements reveal that casing vent gas flows are highly variable and unpredictable, see Figure 7 and Table 2. This implies that in the absence of a suitable storage volume, the GTS low pressure burners must handle a wide range of, and rapid changes in, the vent gas flow rate.

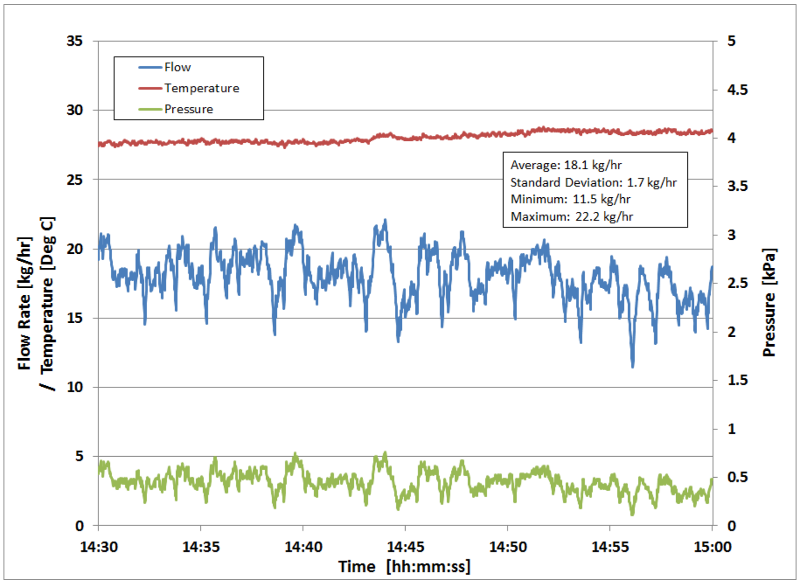

Figure 7: Flow Measurement Results – Test Site C

The flow turndown for a simple burner is a function of the burner's orifice size, minimum supply pressure for stable combustion, and the maximum available supply pressure. Furthermore, the flow through an orifice is proportional to the square root of the differential pressure across the orifice.

In the case of CHOPS applications, vent gas supply pressures as low as 16 – 24 oz/in^2 are desired in order to minimize backpressure on the well and thus maximize oil production. Assuming a minimum supply pressure of 4 oz/in^2 is required for stable combustion, a fixed orifice with a maximum supply pressure of 16 oz/in^2 and an outlet pressure of 0 oz/in^2 (i.e.: zero gauge pressure) would have a flow turndown ratio of 2 (all other things being equal). This result suggests that alternative means are required to achieve the necessary flow turndown ratios to make the CHOPS application feasible.

Table 2: Flow Measurement Results

Site	Flow Rate [kg/hr]			
	Average	Standard Deviation	Minimum	Maximum
A	42.7	14.8	6.3	76.4
B	27.7	14.4	6.9	62.5
C	18.1	1.7	11.5	22.2
D	6.3	0.1	6.1	6.6

Two alternative burner control concepts were evaluated as a means of extending the flow turndown ratio of the GTS burners. With the application of these new concepts, flow turndown ratios in excess of 10:1 are achievable with a pressure turndown ratio of 4:1. This improvement in flow turndown ratio effectively removes the need for a low pressure vent gas storage volume.

4.2 Stack Temperature Limitations

A typical CHOPS oil storage tank is shown in Figure 8. In most installations, the process heater exhaust stack is mounted to the side of the oil tank approximately 12” from the tank surface. In contrast to the GTS auxiliary burner, much of the exhaust energy generated by the process heater is absorbed by the process medium; this implies that higher exhaust gas and thus exhaust stack surface temperatures may be anticipated with the GTS auxiliary burner. Due to the possible presence of combustible vapours and oil storage tank temperature limitations, the proximity of the burner’s exhaust stack to the oil tank is a concern.

Figure 8: CHOPS Storage Tanks and Burners

Field tests with a standard 12" GTS auxiliary burner operating at 274 Mbtu/hr demonstrate that peak exhaust stack surface temperatures may approach 375°C, see Figure 9. Extrapolation of test data to the flow rates required for the CHOPS application reveals that exhaust stack surface temperatures in excess of 600°C may be anticipated without modifications to the existing design. To increase the amount of air flow, and thus mitigate the effects of higher burner outputs, previous versions of the GTS technology relied upon:

- Increasing the "stack effect" by increasing the height of the stack
- Reducing flow losses in the air and exhaust streams

However, in the case of the GTS-CHOPS application, the added weight and cost of a suitably sized exhaust stack and inlet hardware would be prohibitive.

To mitigate the risk, a series of experiments were carried out to examine the merits of various exhaust stack temperature and stack heat transfer reduction strategies. Extrapolation of experimental data suggested that by combining multiple approaches, exhaust stack temperatures could be maintained below the auto ignition temperatures of methane[1] and propane[2] over the entire operational range of the system. Furthermore, heat transfer from the exhaust stack could be effectively limited to ensure oil tank surface temperatures remained below the maximum rated temperature of 90°C.

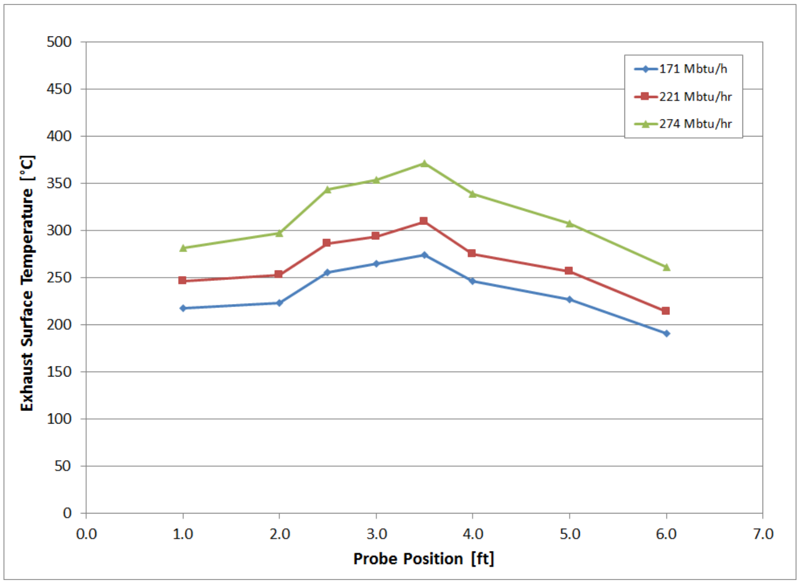

Figure 9: Auxiliary Burner Exhaust Stack Temperature Profile

4.3 Valve Train Hardware Sizing and Selection

Previous versions of the GTS valve train were designed for heat rates of up to 300 Mbtu/hr with supply pressures of approximately 16 oz/in^2. With the GTS-CHOPS application, heat rates on the order of 1050 Mbtu/hr are anticipated. All things being equal, higher heat rates (i.e.: gas flows) result in greater pressure loss across the valve train and vent gas supply header. With the need to minimize the back pressure on the casing vent to maximize oil production, the pressure loss across the valve train and vent gas supply header is a critical design consideration.

A pipe loss model was generated for the SlipStream GTS-CHOPS low pressure valve train using Virtual Materials Group's VMGSim software. The model included pipe losses associated with the valve train piping, fittings, and valves. The model revealed the standard GTS casing vent gas supply header and valve train layout would introduce too much pressure loss at the elevated flow rates characteristic of the CHOPS application. A sensitivity study identified that the key areas for concern were:

[1] Autoignition temperature: 570°C
[2] Autoignition temperature: 470°C

- Casing vent gas header
- Capacity of the solenoid shutoff valves

By increasing the size of the standard casing vent gas header and the capacity of the solenoid shutoff valves, a modified design was shown to reduce pipe losses to below 1 oz/in^2, see Table 3.

Table 3: Valve Train Pressure Loss

Valve Train Design	Valve Train Pressure Loss [oz/in^2]	
	Low Pressure Auxiliary Burner	Low Pressure Main Burner
Standard	3.41	2.81
Modified	0.77	0.63

4.4 Site Power Limitations

Due to the remote location of CHOPS facilities, electrical power is generally limited to what can be generated on site. For most sites, electrical power comes in the form of 12 VDC power generated from an alternator powered by the engine. Unfortunately, these system are often already running near their maximum capacity and are unable to support the additional power requirements for the GTS system.

Due to the unpredictable nature of the casing vent gas supply and the need to minimize backpressure on the casing vent, the use of casing vent gas powered pneumatic devices is typically avoided. Options include using propane, for which there is a cost impact to consider, or hydraulic pressure from the hydraulic pump.

An analysis of the electrical power requirements for the GTS-CHOPS prototype indicated that as much as 700 W (at 24 VDC) may be required, which is approximately 50% of the electrical power already produced on site. While there are many possible alternatives for generating the additional power, adding a second industrial generator to the reciprocating engine, which is typically less than 70% loaded, provides a simple, cost effective, and reliable alternative.

4.5 Heat Recovery

The majority of CHOPS facilities are located in the Peace River, Lloydminster and Wabasca regions of Alberta and the Lloydminster region of Saskatchewan, where minimum daily ambient temperatures during the winter months are often below –20°C and extremes below –40°C are possible. During these months, equipment reliability can be a problem and the remoteness of the sites only serves to aggravate the situation.

One of the primary concerns during the winter months is freeze-off of the fuel lines that supply casing vent gas and/or propane to the reciprocating engine and oil tank heater. With the limited electrical power available on site, CHOPS facilities rely upon waste heat from the reciprocating engine's jacket water coolant system to heat trace the oil and gas lines between the well head, engine shack, and oil storage tank. Feedback from end users suggests that many sites are only just able to keep up with current heat tracing demands and would not be able to support any additional heat loads imposed by the addition of the GTS technology.

An estimate of the additional heat load demanded by the addition of the GTS hardware was used as the basis to evaluate different ways of generating heat from the GTS-CHOPS system. As part of the evaluation the following items were considered:

- Integration of the heat recovery system into the existing site infrastructure
- Equipment reliability and maintenance requirements
- Temperature control and safety shutdown functionality
- System cost and development time
- Additional operational benefits

A number of promising design options were identified for further experimental evaluation during prototype testing.

4.6 Stack Design and Support

A number of technical elements must be considered with the mechanical design of the auxiliary burner and exhaust stack for the GTS-CHOPS application including:

- Material selection
- Manufacturing
- Assembly, maintenance and serviceability
- Integration with existing infrastructure
- Sizing and structural support

Of particular concern during the conceptual evaluation were the questions of stack support and material selection. Existing stacks at CHOPS facilities range from 6” to 10” in diameter and maybe upwards of 25’ in length. The oil storage tank structure supports the weight of the stack, as well as the air inlet flame arrestor and fire tube, and resists any external forces including wind loads.

Estimates for the combined auxiliary burner and stack assembly for the GTS-CHOPS application placed the weight of the assembly at 2 – 3 times the weight of the existing exhaust stack. A notable increase in stack cross-sectional area and thus wind loading was also anticipated due to the increase in stack size required by the GTS-CHOPS design.

A rudimentary static analysis that included the stack weight and expected wind loading was performed. The results of the analysis suggested that a thicker material with a higher allowable design stress and improved resistance to corrosion at elevated temperatures would be required compared to previous GTS designs. Furthermore, the analysis indicated that some measure of support independent of the oil storage tank structure would be required to ensure that structural limits were not exceeded.

5 PROTOTYPE DESIGN

5.1 Accomplishments

After addressing the major technical risks identified during the conceptual evaluation of the SlipStream GTS-CHOPS application, work began on an alpha prototype for functional and performance testing. Upon completion of the detailed prototype engineering the following technical documents were prepared as part of this work:

- Auxiliary burner and exhaust stack manufacturing drawings
- Auxiliary burner, main process burner, and heat recovery system piping and instrumentation diagrams
- Supervisory control panel manufacturing drawings
- Burner management system interconnect drawings
- Control philosophy and function design description
- Control input/output list, shutdown key, and logic diagrams
- Prototype bill of materials and pricing work sheet

An internal “what if” based process hazards analysis was carried out to mitigate any risks that may not have been identified during the design phase. The analysis considered the following:

- Auxiliary burner hardware, instrumentation and process control
- Main burner hardware, instrumentation and process control
- Heat recovery system hardware, instrumentation and process control
- Environmental effects and operational considerations
- Source gas composition changes

Upon completion of the hazards analysis the finalized design was presented to an extensive internal panel for a high level design review and go / no go decision.

5.2 Cost Evaluation

Capital and operational costs are a major concern for operators of CHOPS facilities. In order for operators to adopt new technology, it must be reliable and cost effective regardless of the benefit it provides. An initial market assessment suggested that the market could bare a maximum GTS-CHOPS sell cost of $70,000 and installation cost of $25,000. ,

Concerns were raised as to whether the GTS technology could be cost effectively applied to the CHOPS application given the additional functionality and complexity demanded. The results of a detailed cost estimate for the completed prototype design are shown in Table 4.

Table 4: GTS-CHOPS Prototype Cost Breakdown

Description	Estimated Cost [$ CDN]
Valve Train Hardware and Instrumentation	40,900
Burner Hardware and Instrumentation	33,800
SlipStream Hardware and Instrumentation	20,100
Heat Recovery Hardware and Instrumentation	31,700
Power System Hardware	5,000
Installation / Commissioning Parts and Labour	56,800
Total	188,300

It is clear from the cost estimate that even with significant costs reductions and the benefits from economy of scale, it would be highly unlikely to achieve the $95,000 installed cost target. The key contributors to the added cost relative to previous GTS designs included:

- The provision for heat recovery for the glycol heat tracing system
- The scope of changes required to complete the installation
- The additional modifications required to safely handle the large flow and flow variations

6 CONCLUSION

Vented methane from Cold Heavy Oil Production with Sand (CHOPS) facilities is a significant contributor of greenhouse gas emissions from Alberta's and Saskatchewan's oil and gas activities. The release of this combustible hydrocarbon resource from CHOPS facilities also represents the loss of an otherwise viable energy source.

This report summarized the initial development of a SlipStream GTS system for CHOPS applications using REM Technology Inc.'s patent pending SlipStream GTS technology. The primary objective of the work was to create and evaluate a functional SlipStream GTS prototype that could be integrated with the existing oil storage tank heater at CHOPS facilities and used to capture and eliminate combustible hydrocarbon gases from the well casing vent. In addition to reducing site emissions, improvements in equipment and operational reliability, as well as a reduction in on-site propane usage were anticipated.

The project development was executed by representatives of REM Technology Inc. and Spartan Controls Ltd., and supported in part by the Petroleum Technology Alliance of Canada (PTAC). The scope of work for the project included:

1. Scope definition and design constraints
2. Conceptual evaluation
3. Prototype design
4. Prototype fabrication
5. Prototype evaluation
6. Prototype design updates
7. Final Report (PTAC)

Items 1 through 3 of the original scope of work were completed. Upon completion of the prototype design phase, a detailed analysis of the installed system cost for a production unit indicated that SlipStream GTS based solution would be too costly, even though the solution was technically viable. Based on these findings, the development work on the SlipStream GTS-CHOPS application was concluded prior to fabricating the prototype.

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END OF DOCUMENT