 

Energy Efficiency and Emissions Reduction using RemVue/Slipstream Technology

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Methane to Markets Oil & Gas Technology Transfer Workshop
Lake Louise, Alberta, September 15, 2009

Methane to Markets

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ConocoPhillips Canada **“Green”** Initiatives:

- ConocoPhillips Canada Background
  - Significant Producer → # 3 Fuel gas user in Alberta
  - Declining production = increasing fuel gas intensity
  - Carbon Taxes adding to Operating costs

- Strong Corporate Commitment to Emissions Reduction and Energy Efficiency
- Energy Efficiency team in place for 3 years
  - Technology evaluation and roll-out
  - Project tracking and reporting

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Technology to Improve Efficiency and Reduce Emissions

- RemVue®
  - Air/Fuel Ratio Control
  - Reduced Fuel Gas (CO_2, NO_x) in Natural Gas Engines

- SlipStream®
  - Captures Vented Gas and Burns it in Engines
  - "Piggy-Backs" on RemVue

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RemVue Air/Fuel Ratio Control

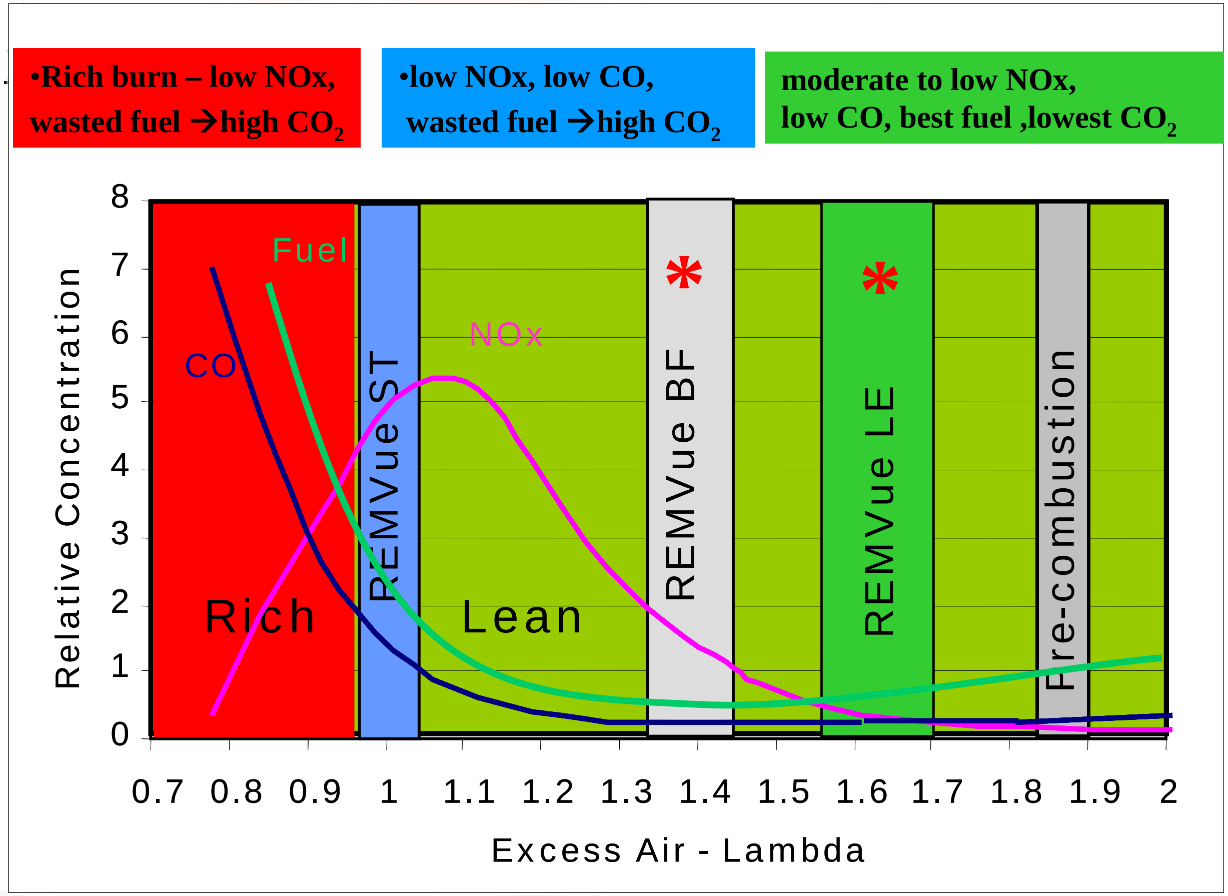
- Controls Air Fuel mixture to the engine
  - Theory – Lean fuel mixture = better combustion = less fuel gas required
  - Lower CO2e emissions

- Adaptive Control System - Air/Fuel Control alone isn't enough
  - Must be able to operate through "upsets"
  - Load Swings, Pressure Swings, Temperature swings, low temperatures
  - Engine shut-downs not acceptable

RemVue Air/Fuel Ratio Control

Operational Regimes

1. Rich
2. Stoichiometric
3. * Lean – Best fuel
4. * Lean – Low NO_x



In stoichiometric or rich burn engines, much of the energy goes "up the stack" or to the catalytic converter in the form of CO and unburned methane

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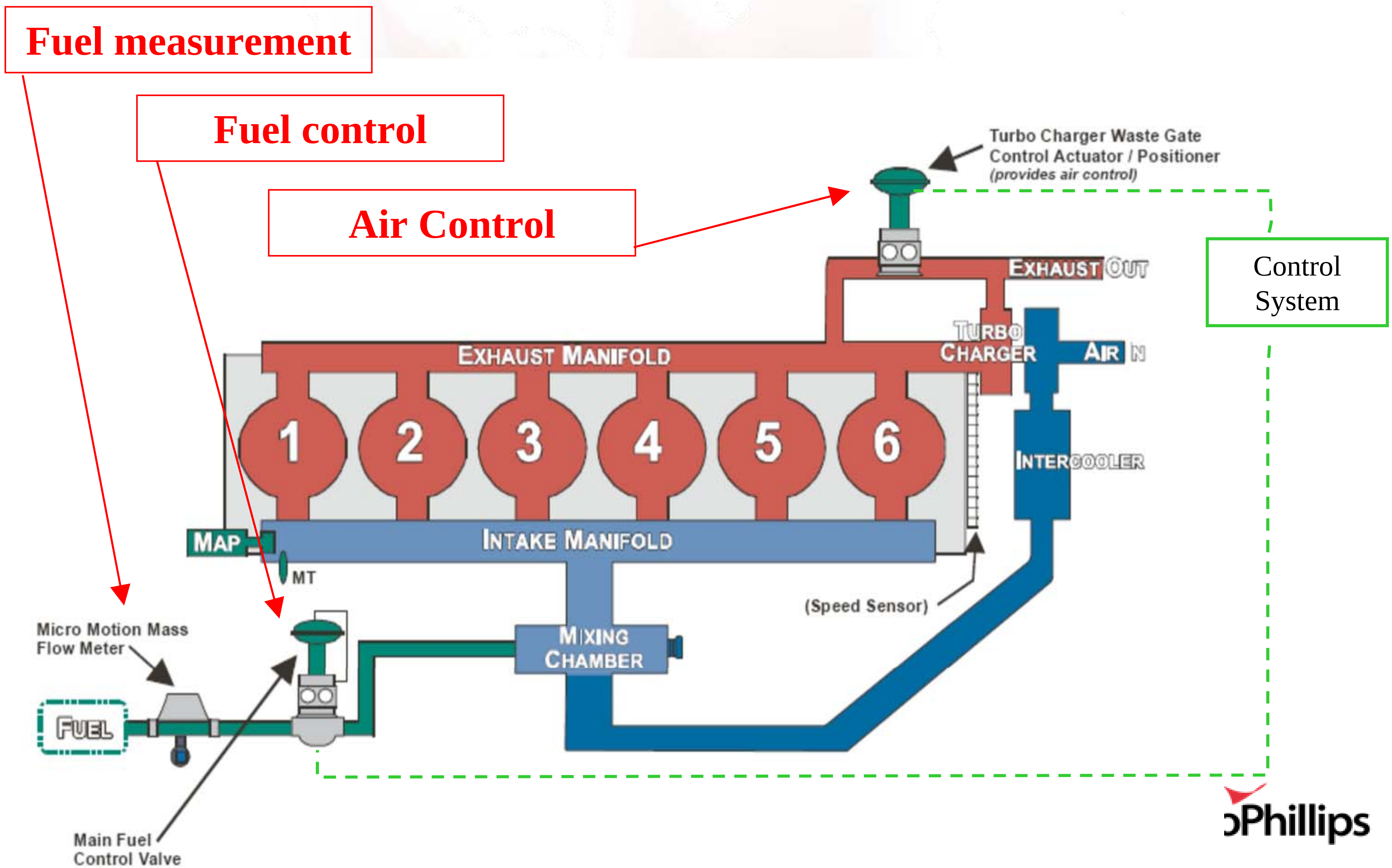
RemVue Air/Fuel Ratio Control



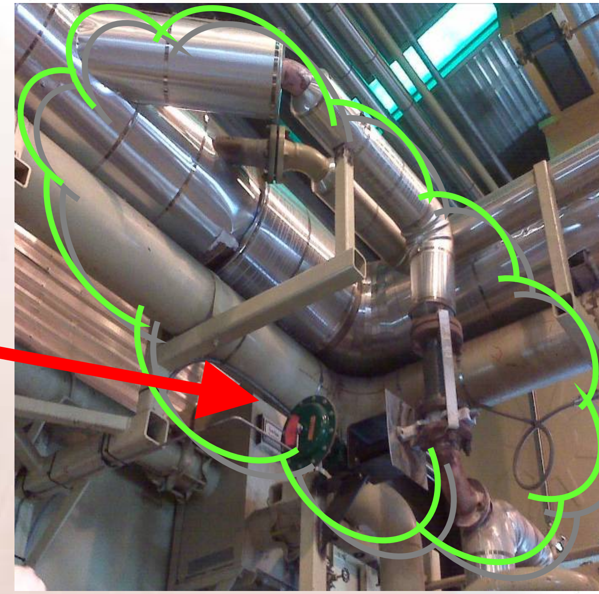
RemVue Air/Fuel Ratio Control – Field Install details

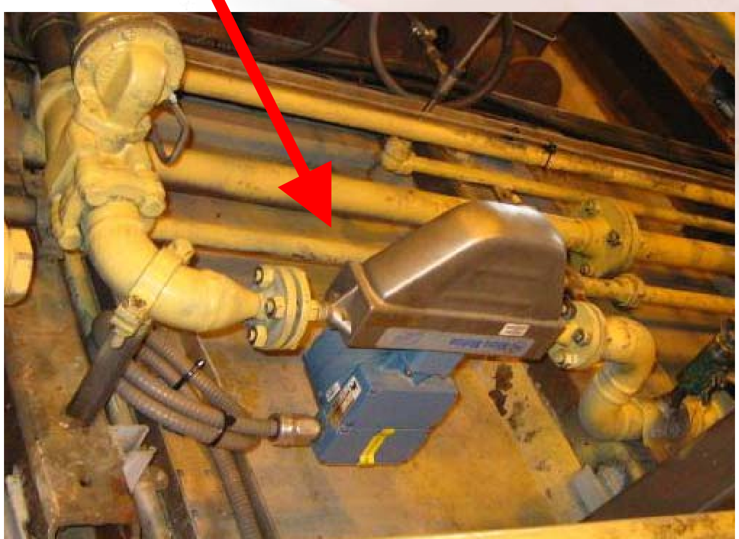
Fuel measurement

Fuel control

Air Control

Control System





RemVue Air/Fuel Ratio Control

- Mechanical scope of work
  - Fuel Gas Meter
  - Fuel Gas Control Valve
  - Exhaust Valve to control air-flow
  - air-intake manifold balance line (if required)
- Electrical/Instrument scope of work
  - Speed pick-up
  - Air-inlet pressure transmitter(s)
  - Fuel gas meter
  - i/p transducers for fuel and exhaust control valves
  - Manifold temperature thermocouple(s)
- Pre and Post-Audits
  - Verify performance
  - Program engine load-map and control

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RemVue Air/Fuel Ratio Control

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	Engine	Pre-RemVue Fuel kg/hr	Post-RemVue Fuel kg/hr	Pre-RemVue BSFC - btu/bhp-hr	Post-RemVue BSFC - btu/bhp-hr	Average Fuel Gas Savings
1	Waukesha 7042GSI	240	184	10,122	7,823	23.0%
2	Waukesha 7042GSI	191	148	9,289	7,386	21.5%
3	Waukesha 7042GSI	192	163	8,540	7,460	13.9%
4	Waukesha 7042GSI	163	137	8,400	7,447	13.7%
5	Waukesha 7042GSI	274	238	8,661	7,552	13.0%
6	Waukesha 7042GSI	200	172	10,014	9,012	11.9%
7	Waukesha 7042GSI	170	148	8,636	7,678	11.9%
8	White-Superior 16G-825	149	133	9,892	9,138	9.2%
9	Waukesha 7042GSI	266	254	9,875	9,318	5.0%

Exhaust temperatures ~70 C cooler

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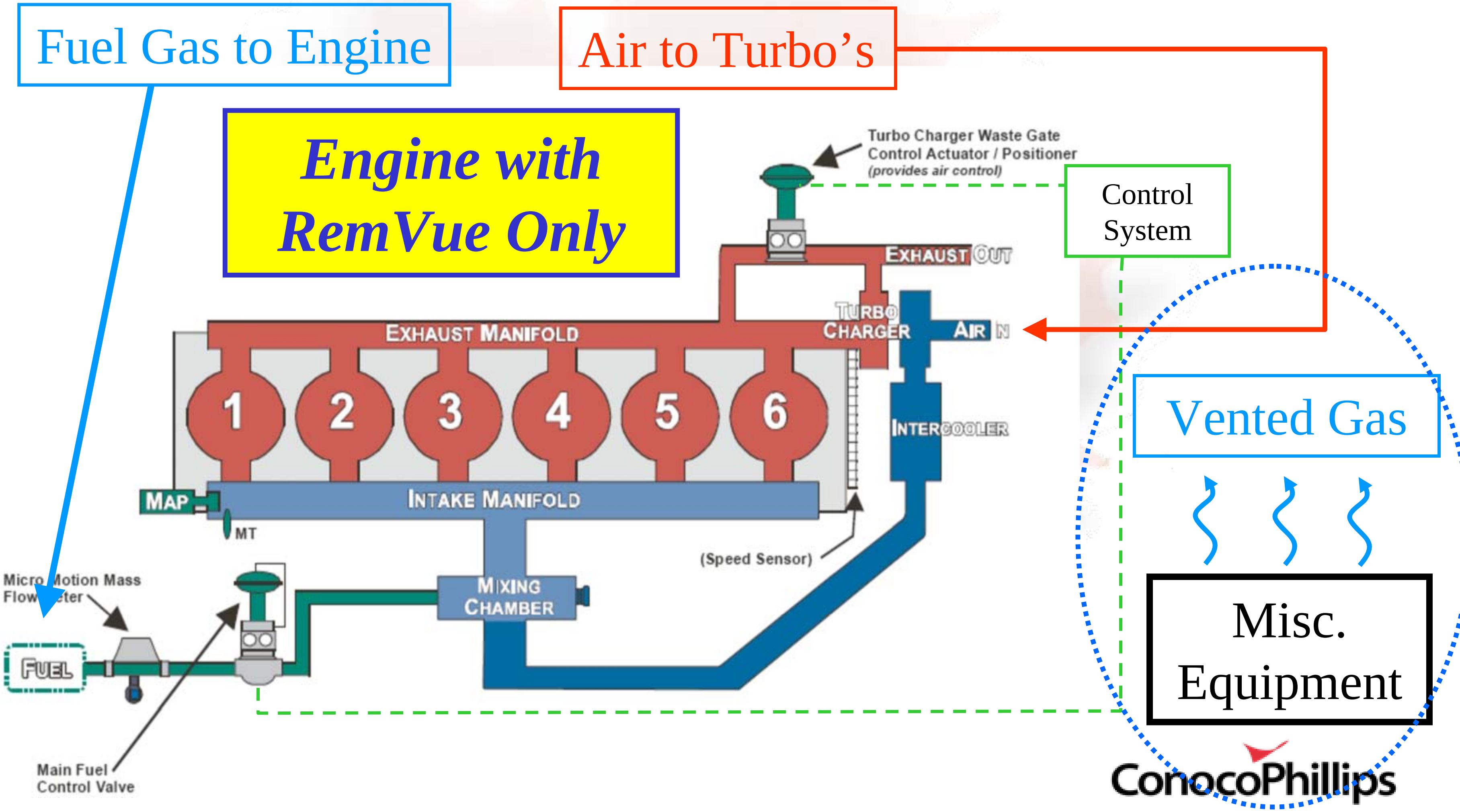
SlipStream Vent Gas Capture System

- Captures gas that is normally vented to atmosphere and burns this as engine fuel gas
  - Instrumentation and pump gas vents
  - Compressor packing and seals
  - tank vapours, ...

- Installed on engines that have RemVue in place
  - Vented gas is blended with engine air (non-standard operation)
  - Need Robust controls to ensure stable operation with this additional fuel source
  - SlipStream control module – minor RemVue panel addition

SlipStream Vent Gas Capture System



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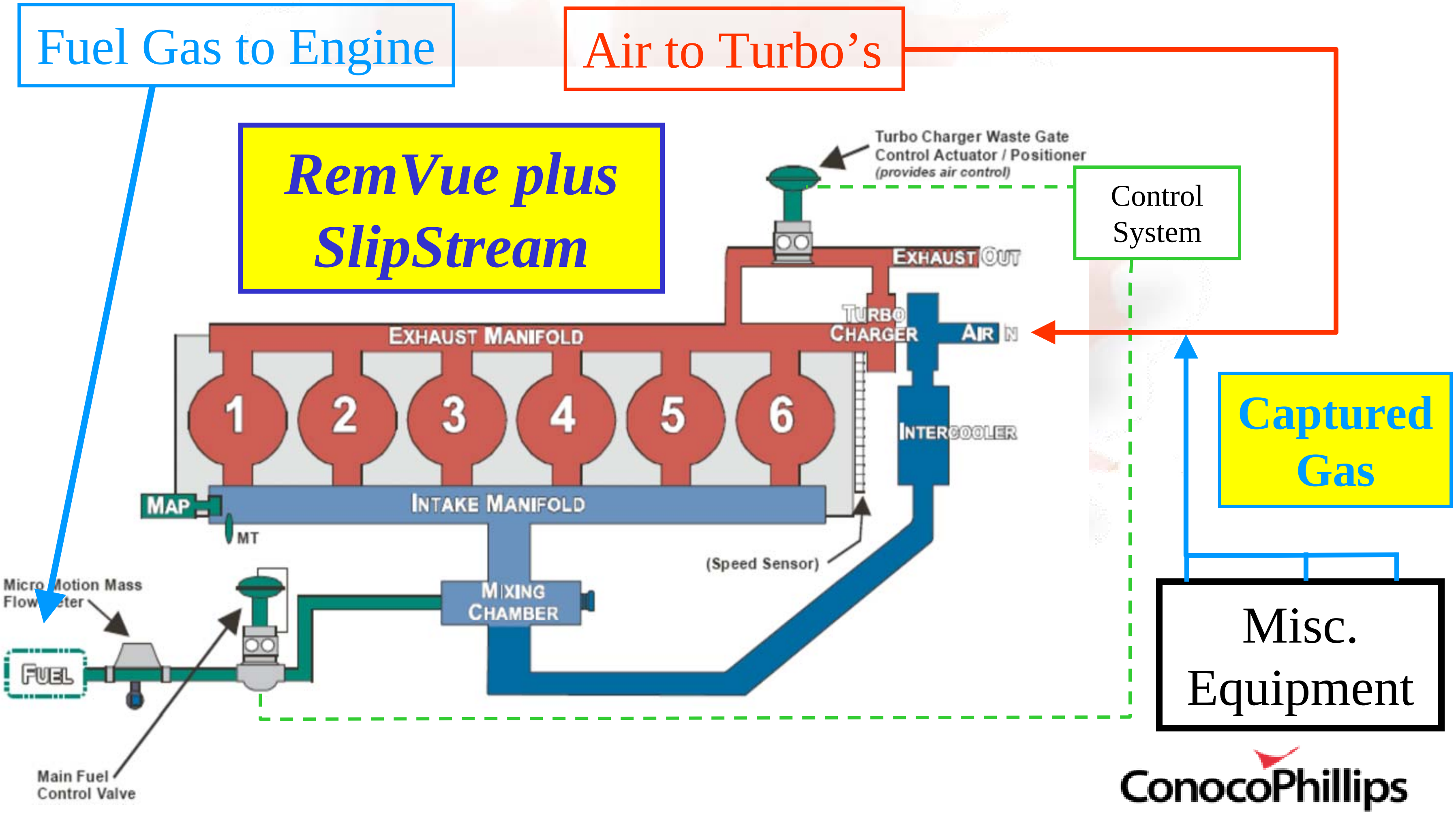
SlipStream Vent Gas Capture System



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SlipStream Vent Gas Capture System – Noel Gas Plant

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SlipStream – Noel Gas Plant

- Noel Gas Plant
  - Located in British Columbia
  - 150 MMscfd Process Capacity
  - 4 Inlet compressors – 2200 hp each
  - 5 Sales compressor – 1478 hp each
- Vent gas sources???
  - Plant has instrument air – therefore no instrument vents
  - Main vented gas from compressor packing vents

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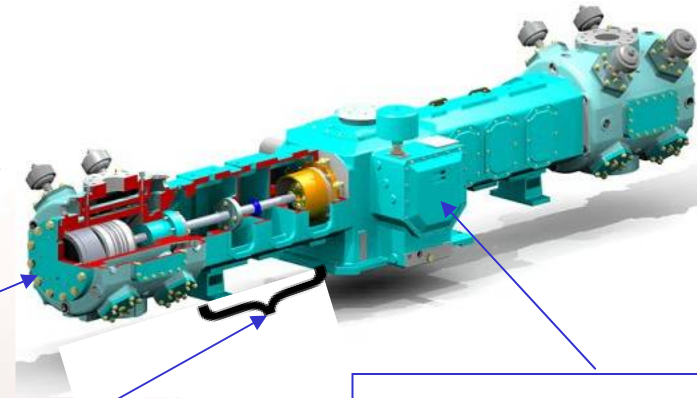
SlipStream – Noel GP

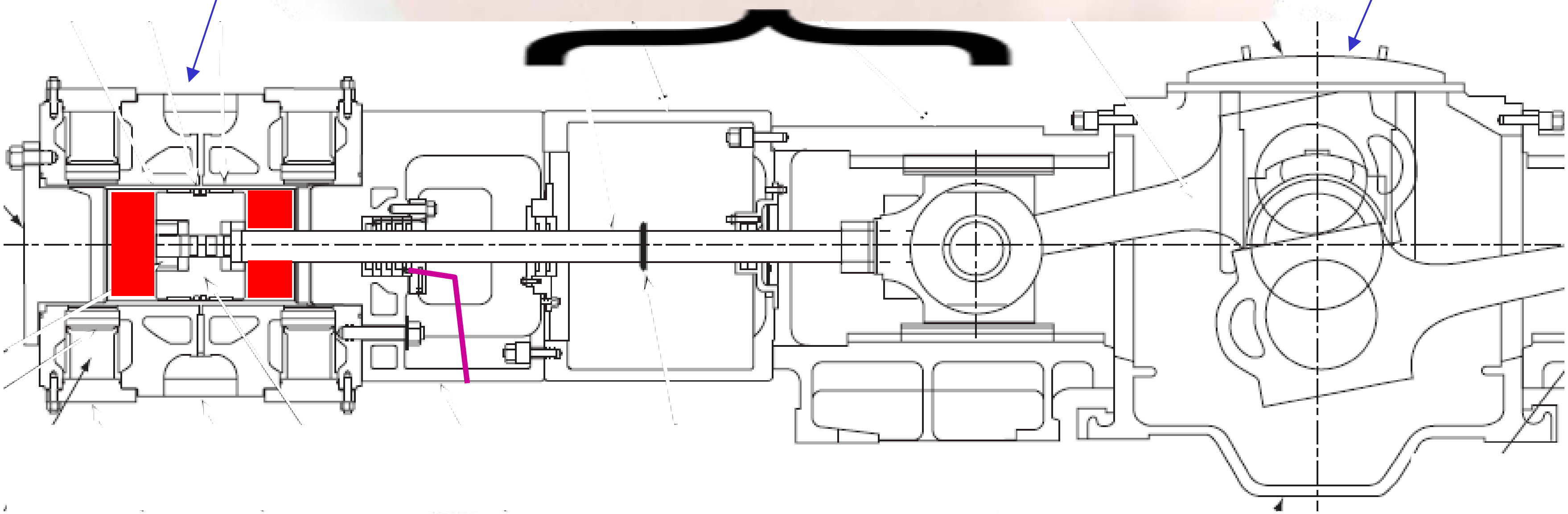
Reciprocating Compressors – Components



Crankcase

Cylinder

Distance Piece



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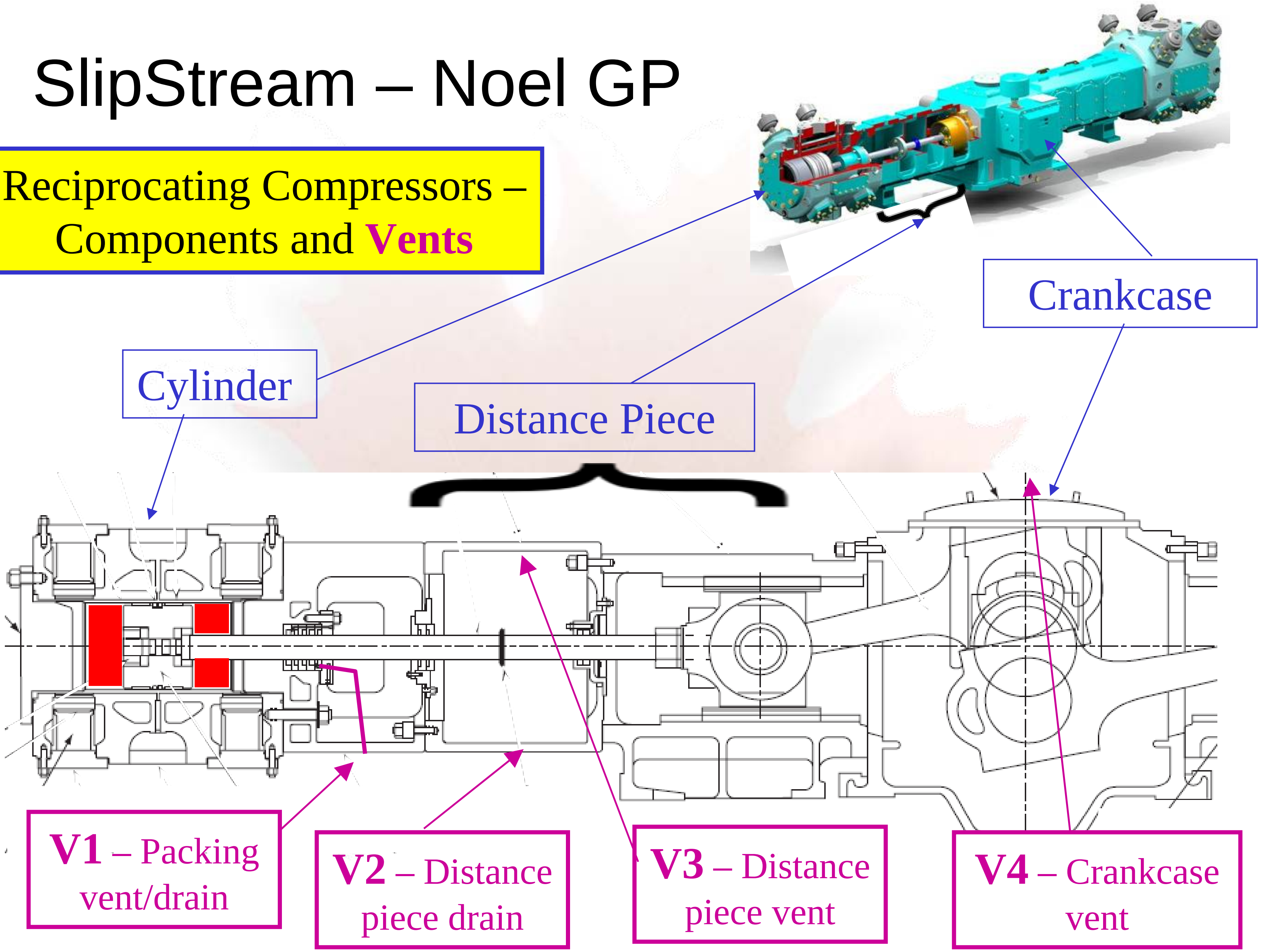
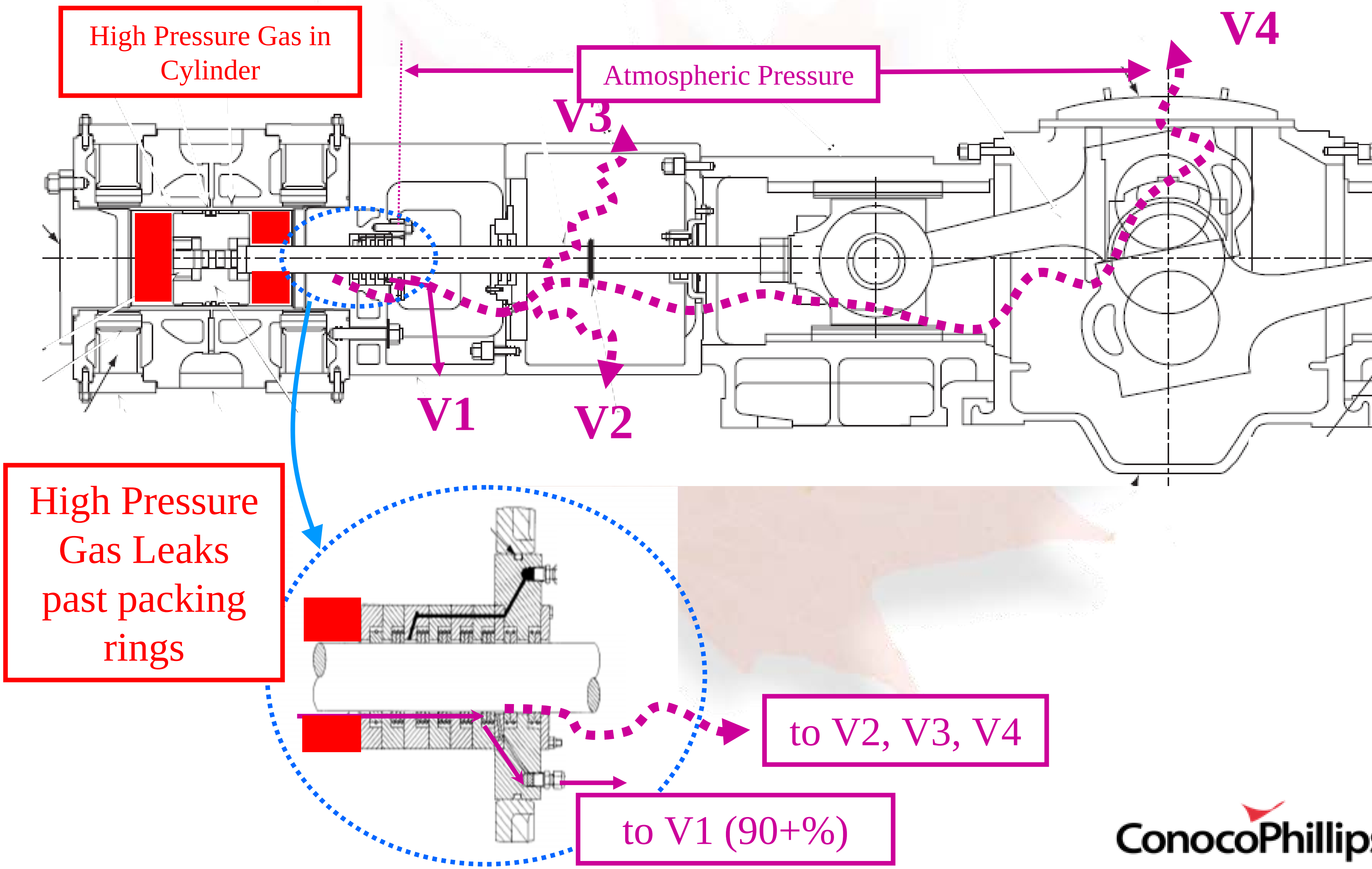
SlipStream – Noel GP

Reciprocating Compressors – Components and **Vents**



SlipStream – Noel GP – Vent Details



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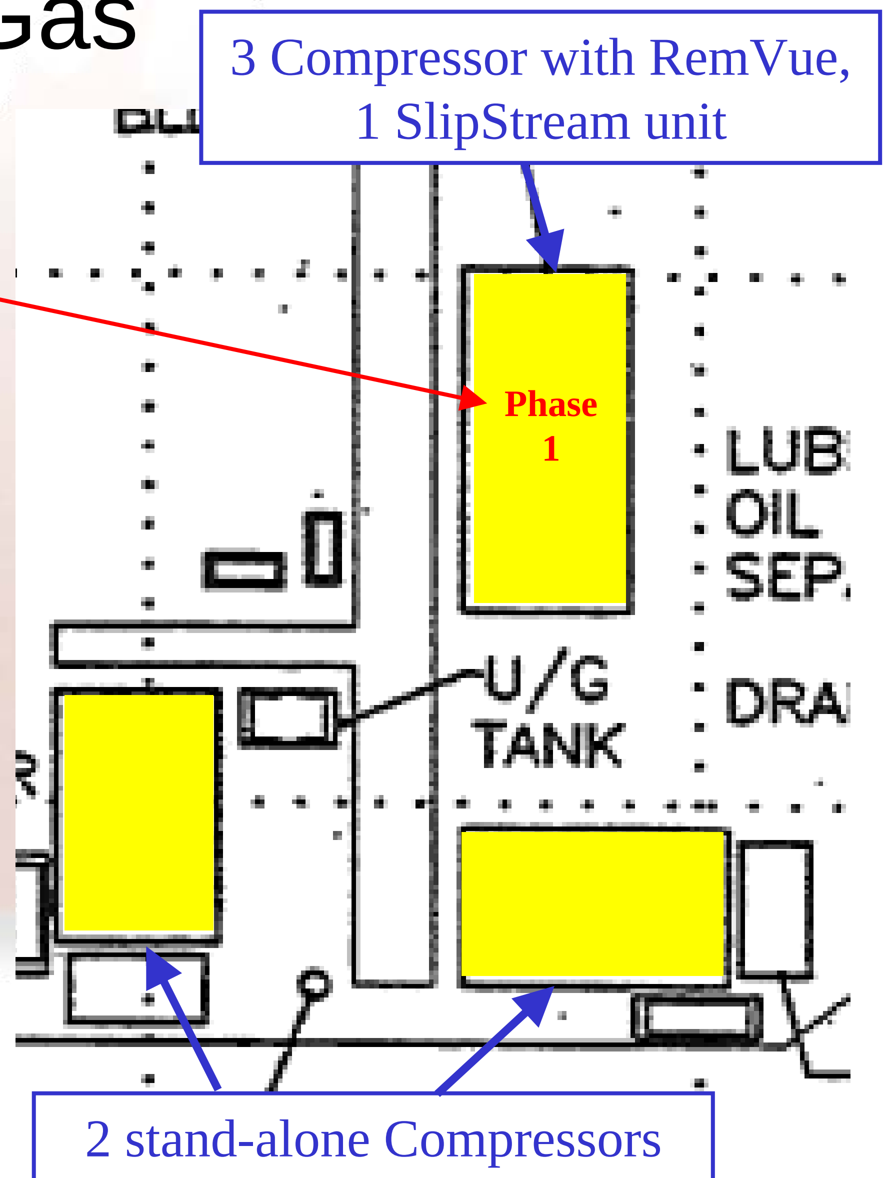
SlipStream – Noel Gas Plant – Vented Gas

- Sales Compressors
  - **3 @ 3-cylinder (Phase 1)**
  - 2 @ 4-cylinder
- Inlet Compressors
  - 4 @ 6-cylinder
- Total Plant
  - 41 cylinders (packing leaks)



Vented Gas Stream from Compressor Packing etc.

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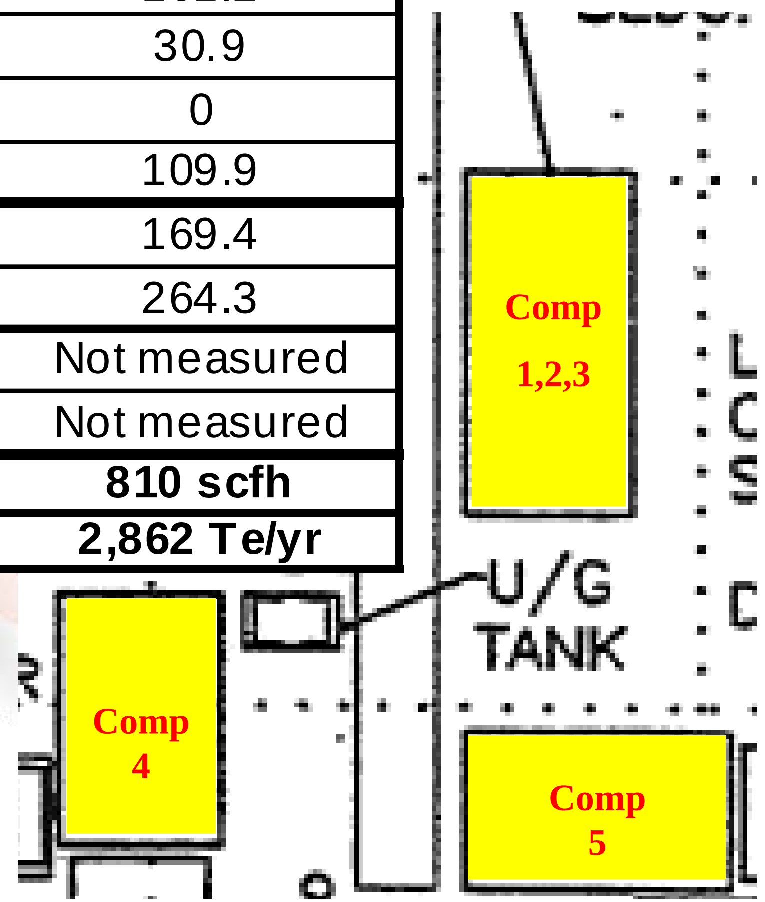
SlipStream – Noel Gas Plant – Vented Gas

	Gas Source	Vented Gas (scfh)
Phase 1	Comp 1 Packing and Distance Piece	76.5
	Comp 2 Packing and Distance Piece	57.8
	Comp 3 Packing and Distance Piece	101.2
	Comp 1 Crankcase Vent	30.9
	Comp 2 Crankcase Vent	0
	Comp 3 Crankcase Vent	109.9
Phase 2	Comp 4 Packing and Distance Piece	169.4
	Comp 5 Packing and Distance Piece	264.3
	Comp 4 Crankcase Vent	Not measured
	Comp 5 Crankcase Vent	Not measured
	Total Gas Savings	**810 scfh**
	Total CO2e Reduction	**2,862 Te/yr**



SlipStream – Noel Gas Plant – Design Basis

- Potential Gas Capture of 810 scfh
- Install SlipStream on 1 compressor – capture vents from many
- Phased Vent-Capture Scope:
  - Capture vents from 3 Sales Compressors in same building to prove-up concept
  - Capture vents from 2 other nearby Sales Compressors
  - Capture vents from 4 inlet compressors ($$ piping cost)
- Unique Design Attribute – Air Intake System
  - “Old-School” oil bath air inlet filter on engine
  - Results in negative air intake pressure of -9” WC to -27”WC
  - Decided to take advantage of this to “vaccuum-up” the vents to reduce piping complexity

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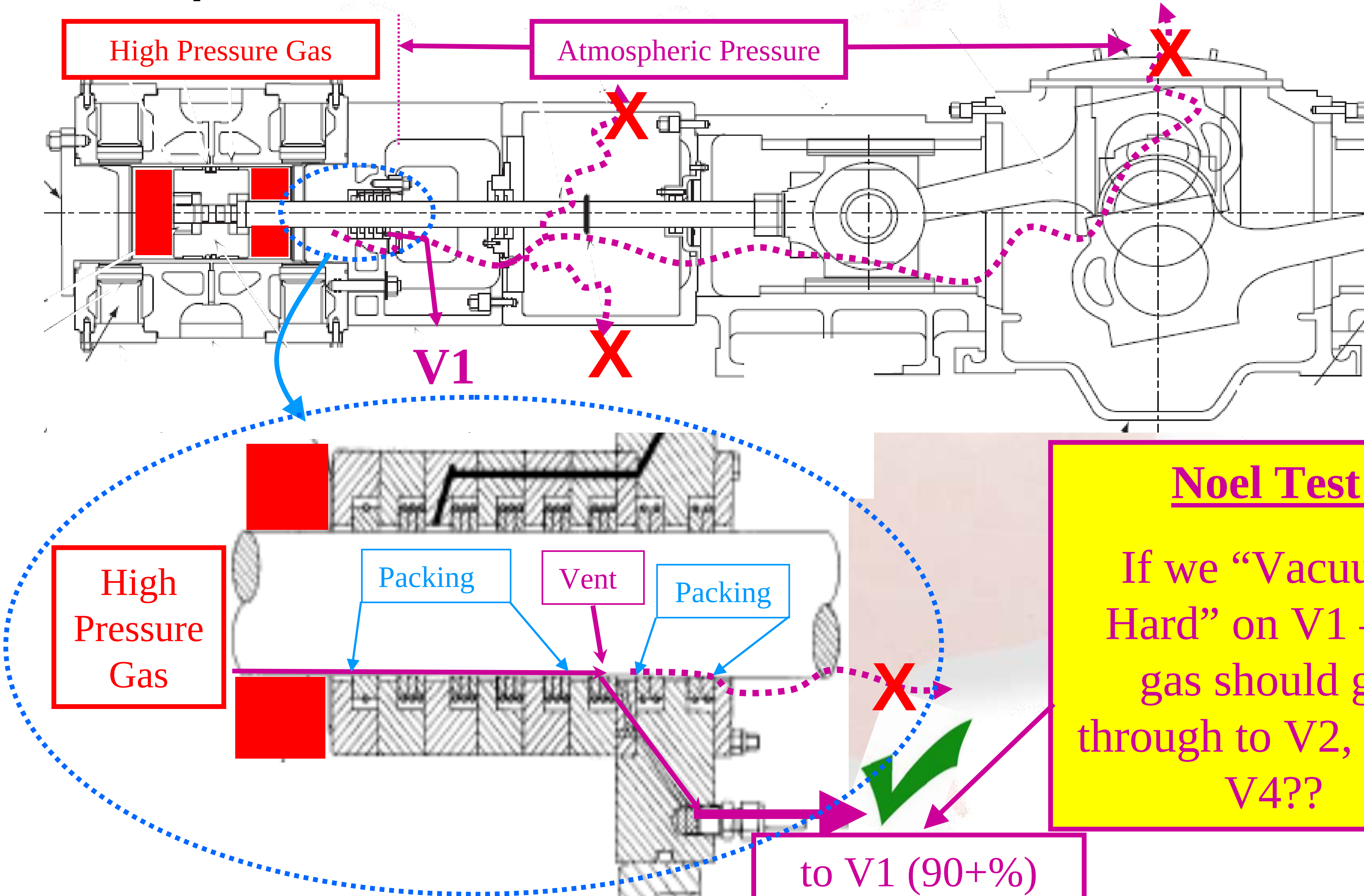
SlipStream – Noel GP – Vent Details



Noel Test:

If we "Vacuum-Hard" on V1 – no gas should get through to V2, V3 & V4??

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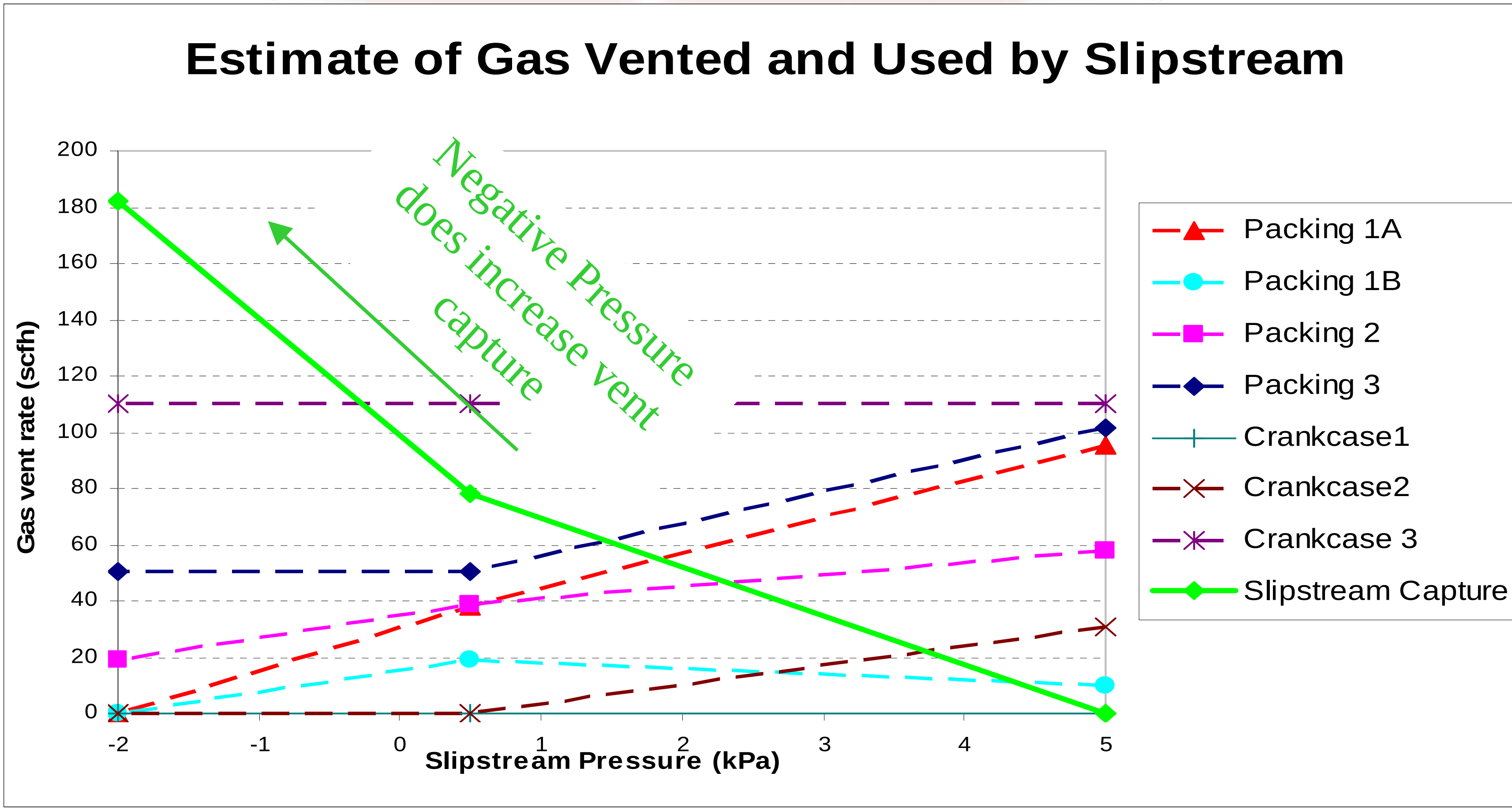
SlipStream – Noel Gas Plant – Results

- “Vacuum” system captured about 25% of the vented gas
- Various theories – plugged lines, pressure drop, ...
- Will tie-in remainder of vents to capture 100% of gas



Next Steps

- SlipStream – Noel Gas Plant
  - Tie-in all vent sources to capture 100 % of vented gas for the first 3 compressors
  - Evaluate tie-in of other compressors
  - Evaluate other potential vent sources on-site (compressor maintenance blow-down gas, tanks,)

- RemVue and SlipStream Next Steps
  - Identify other RemVue and SlipStream opportunities in our Operations
  - Low horsepower test – to meet emissions, and fuel reduction

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Project Learnings

- Project Learnings
  - Many vent gas capture projects are small, retrofit projects
  - <u>Both</u> of these factors have significant cost escalation risk
  - Need thorough design before construction (a few dollars on paper can save many dollars in steel!)
  - Treat the construction as “maintenance” to reduce costs associated with “formal projects”
  - Local providers are best – travel can be a significant part of a small project
  - RemVue technical learnings – check air-cooler sizing, ensure all operating parameters covered by engine control map

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