



Lessons Learned After Opening a Top Slide Valve on a Live Coke Drum

Horizon Upgrader

Coking & CatCracking Conference-Reliability is Safety

Galveston TX- May 8-10, 2013

Coking.com[®]
MORE PRODUCTION - LESS RISK!



Canadian Natural

- **January 6, 2011**

- **Coke Drum 33-D-1B (one of four drum set) was on-line with a feed rate of 59,000 BPD at full operating pressure & temperature.**
- **The 36” DeltaGuard slide valve on the top head of Coke Drum 33-D-1B was inadvertently opened to atmosphere.**
- **When opened, the valve released the drum contents at 425C (800F) forming a vapor cloud above the top (cutting) deck**
- **The vapor cloud ignited and the explosion and subsequent fire resulted in 5 injuries (3 staff operators and 2 contractors) and significant property damage**
- **The majority of the hydrocarbon in Coke Drum 33-D-1B was released and fed a low pressure jet fire for approximately three hours, destroying the cutting deck and drilling structure above**

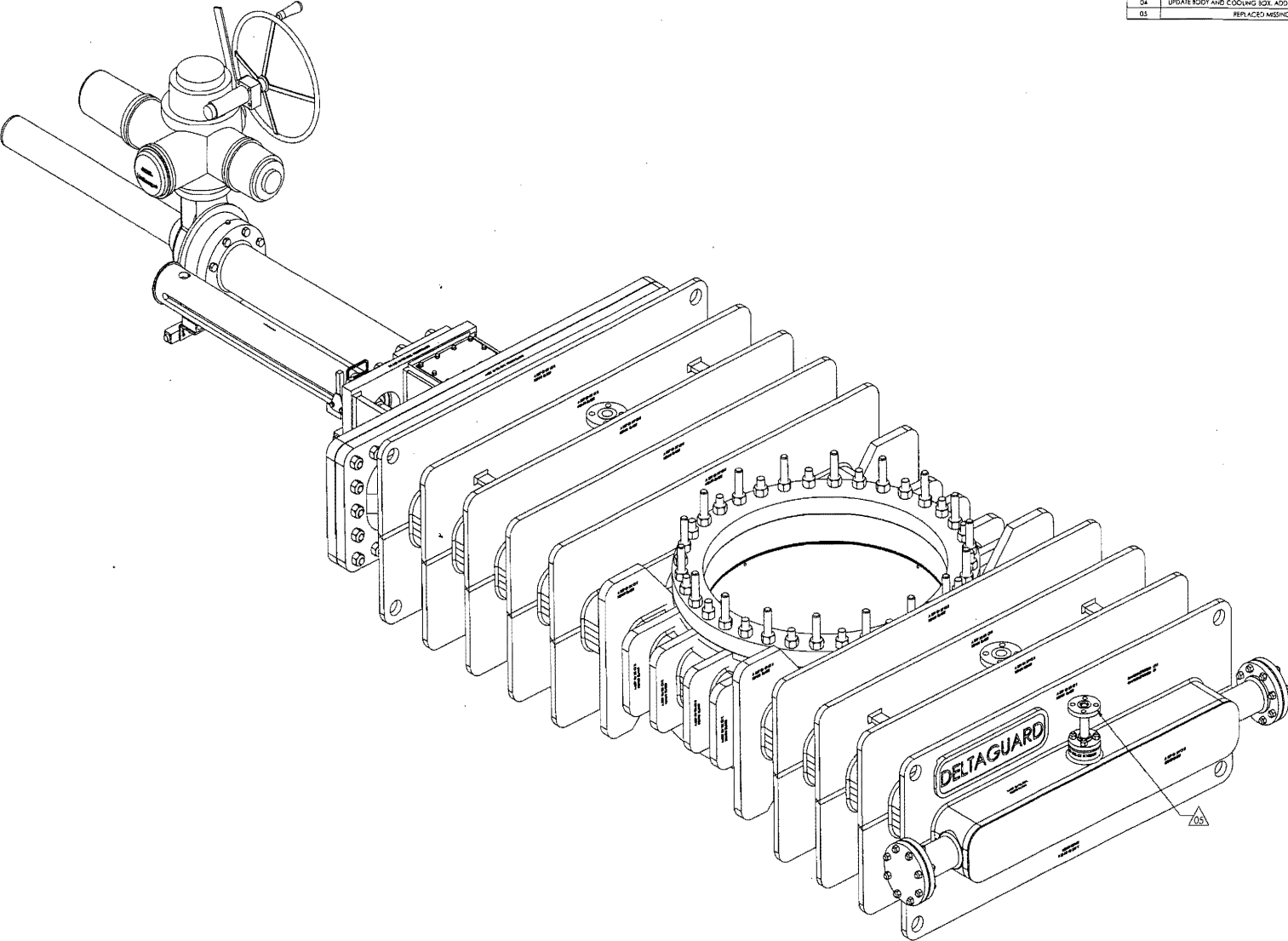
Picture of Fire on top of Coke Drum



- **The online drum 33-D-1B slide valve was opened in error**
 - The top slide valve actuator local bypass switch was not on the Process & Instrumentation Diagram, and was not tied into the safety interlock system
 - On Jan 6 after three to four hours of water quenching, **33-D-1A** was depressured to atmosphere by cutting deck operator A through the vent system. After 30 minutes of waiting for the cool down temperature to be reached, cutting deck operator B was unable to get permissive to open the slide valve. This was a known routine problem and he contacted the control room by radio who bypassed **33-D-1A** SIS based on drum temperature readings in the control room, and asked cutting deck operator B to try again.
 - Cutting deck operator was still unsuccessful to obtain permissive (he believed that **33-D-1B** was the next drum to be cut) and proceeded to **33-D-1B**, pulled the manual shaft locking pin, placed the bypass in “local”, engaged the “open” switch, and walked back to the cutting deck shelter. The slide valve took approximately 150 seconds to fully open on the live coke drum.

Schematic of DeltaGuard Valve

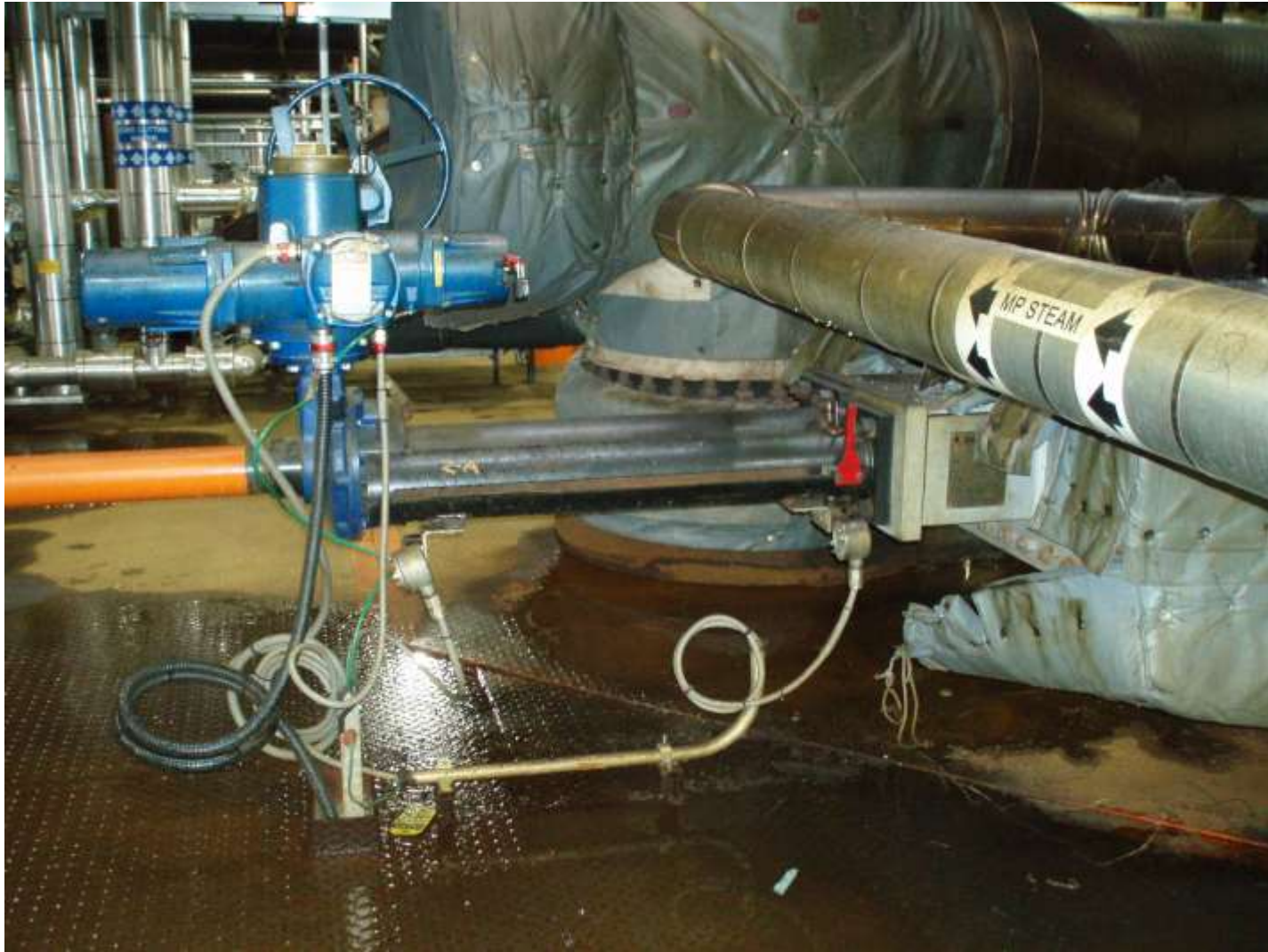
04	UPDATE BODY AND COOLING BOX ADDED MATERIAL
05	REPLACED MISSING EPDOL



Picture of Local Bypass Switch



Picture of Actuator on Top Slide Valve



- **All three operators were in the cutting shelter when they realized the wrong drum had been opened**
 - They were unable to close the valve from the cutting shelter room since the local bypass switch had rendered that control inactive
 - In attempting an escape from the cutting deck, they were caught in the explosion but were largely protected by fireproof coveralls
 - One operator received third degree burns to hands, and second degree burns to face
 - One operator received first degree burns to face
 - One operator received bruised shoulder being thrown against exit door
- **Two maintenance workers were also injured**
 - One worker thrown against shed at ground level and suffered concussion
 - One worker suffered leg strain while climbing down ladder to evacuate the area.

- **The cutting deck and drilling structure received extensive fire damage.**
- **The structure was noticeably leaning and was not deemed structurally sound for access for approximately seven days.**
- **The process unit received extensive ice damage (external and internal) as temperatures hovered near minus 30C during those seven days.**
- **Unit was successfully brought back online after more than seven months of repairs.**

Damage Picture



- **The following safety interlocks had been designed into the system to prevent the top slide valve from being operated under unsafe conditions:**
 - **The Coker drum pressure is low**
 - **The Coker drum overhead temperature is low**
 - **The manual shaft locking pin is pulled**
 - **The switch valve is aligned to the other drum**
 - **The following valves are closed:**
 - **Quench Oil valve**
 - **Blowdown valves**
 - **Overhead vapor valves**
 - **Anti-foam solution valve**
 - **Feed valve**
 - **Condensate valve**

- **Safety interlocks were configured to remain active and prevent the valve opening when the actuator local bypass switch was engaged.**
- **A new permissive was added consisting of 3 sets of panel switches and panel lights which require the operators: in the Main Control Room, on the Switch Deck and in the Cutting Deck Operator Shelter to acknowledge the specific drum to be opened**
- **A stainless steel locking cover was installed to prevent operator access to the actuator local bypass switch**
- **Alarms and warning beacons were installed on the cutting deck, the switch deck, and the Main Control Room to warn the operators if a manual locking pin is pulled on a live drum.**
- **A protected escape route was installed from the Cutting Deck Shelter to the stairway exit.**
- **The training program for Coke Drillers was enhanced by providing specific training on the purpose and function of SIS (Safety Instrumented System), using interactive visual tools**

New Permissive Added



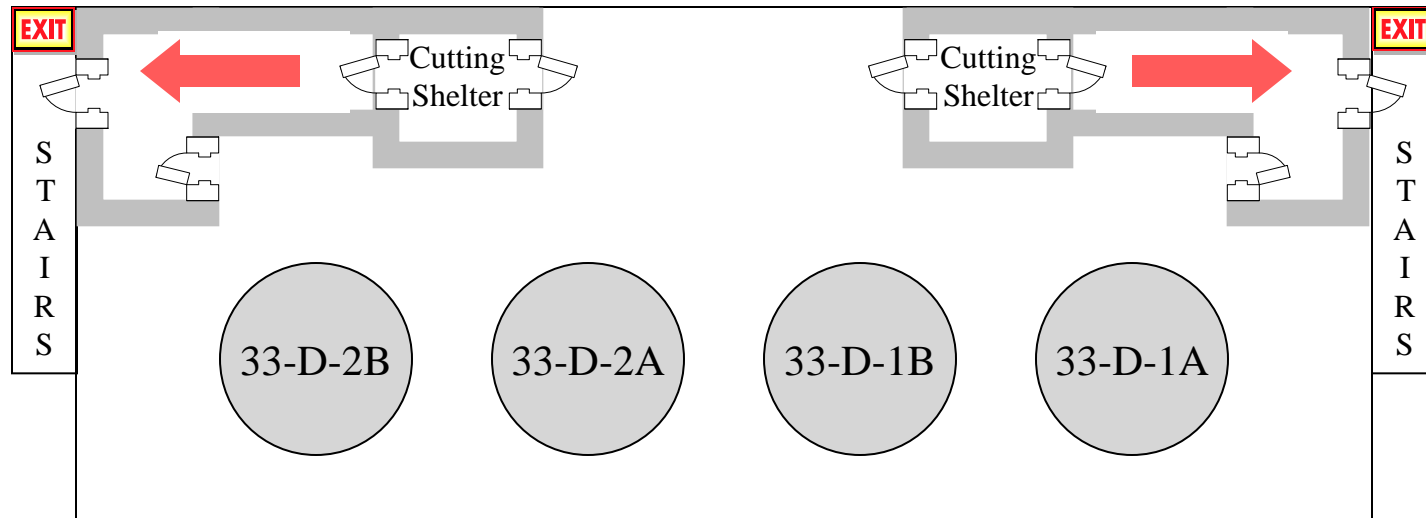
Stainless Steel Locking Cover

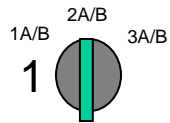
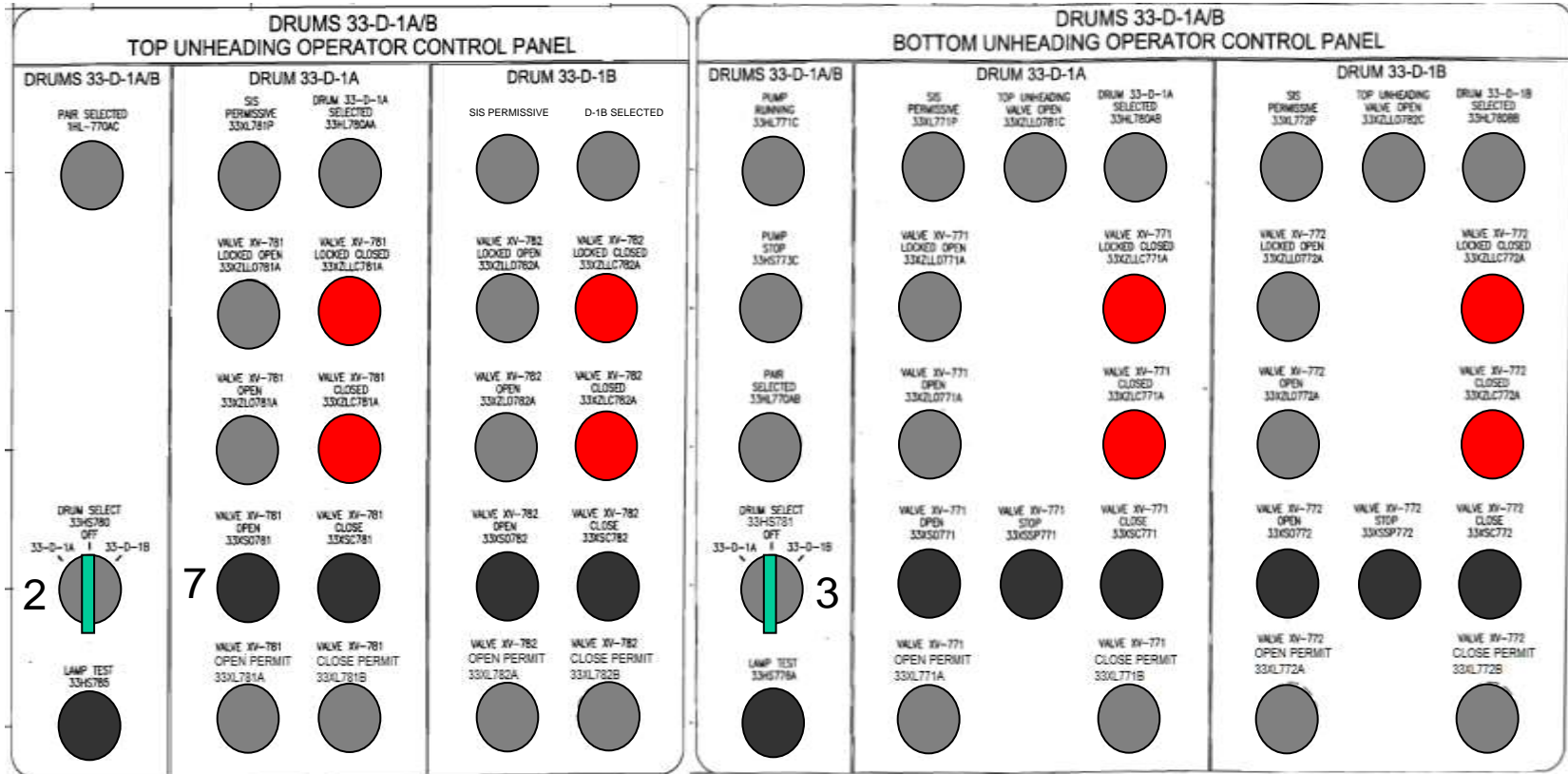


New Warning light and beacon



Protected Escape Route





SIS PERMISSIVE (LOGIC) **4**
DCS PERMISSIVE (PB) **5**

CLOSE PIN PULLED **6**
VALVE FULL OPEN **8**

OPEN PIN INSERTED **9**
SIS PERMIT GONE **10**

SWITCHES BACK

- The SIS system was extensively reviewed during the design stages, thought to be foolproof and thought to only be bypassed by the main control room. After the event, local bypass switches were inspected throughout the plant and two others were found not to be interlocked.
- Checking for **un-approved** local bypass switches has been added to our PHA (Process Hazard Analysis), RFC (Ready for Commissioning) and PSSR (Pre-Start-up Safety Review) checklists.
- The industry use of top slide valves require higher levels of SIS training for Coker Drillers, which are typically entry level operator posts

- **Contact Information:**
 - reno.laseur@cnrl.com

Forward Looking Statements



Certain statements relating to Canadian Natural Resources Limited (the "Company") in this document or documents incorporated herein by reference constitute forward-looking statements or information (collectively referred to herein as "forward-looking statements") within the meaning of applicable securities legislation. Forward-looking statements can be identified by the words "believe", "anticipate", "expect", "plan", "estimate", "target", "continue", "could", "intend", "may", "potential", "predict", "should", "will", "objective", "project", "forecast", "goal", "guidance", "outlook", "effort", "seeks", "schedule" or expressions of a similar nature suggesting future outcome or statements regarding an outlook. Disclosure related to expected future commodity pricing, forecast or anticipated production volumes, royalties, operating costs, capital expenditures, income tax expenses and other guidance provided throughout this Management's Discussion and Analysis ("MD&A") including the information in the "Outlook" section and the sensitivity analysis constitute forward-looking statements. Disclosure of plans relating to and expected results of existing and future developments, including but not limited to the Horizon Oil Sands operations and future expansion, ability to recover insurance proceeds, Primrose, Pelican Lake, the Kirby Thermal Oil Sands Project, the Keystone XL Pipeline US Gulf Coast expansion, and the construction and future operations of the North West Redwater bitumen upgrader and refinery also constitute forward-looking statements. This forward-looking information is based on annual budgets and multi-year forecasts, and is reviewed and revised throughout the year as necessary in the context of targeted financial ratios, project returns, product pricing expectations and balance in project risk and time horizons. These statements are not guarantees of future performance and are subject to certain risks and the reader should not place undue reliance on these forward-looking statements as there can be no assurances that the plans, initiatives or expectations upon which they are based will occur.

In addition, statements relating to "reserves" are deemed to be forward-looking statements as they involve the implied assessment based on certain estimates and assumptions that the reserves described can be profitably produced in the future. There are numerous uncertainties inherent in estimating quantities of proved and proved plus probable crude oil and natural gas reserves and in projecting future rates of production and the timing of development expenditures. The total amount or timing of actual future production may vary significantly from reserve and production estimates.

The forward-looking statements are based on current expectations, estimates and projections about the Company and the industry in which the Company operates, which speak only as of the date such statements were made or as of the date of the report or document in which they are contained, and are subject to known and unknown risks and uncertainties that could cause the actual results, performance or achievements of the Company to be materially different from any future results, performance or achievements expressed or implied by such forward-looking statements. Such risks and uncertainties include, among others: general economic and business conditions which will, among other things, impact demand for and market prices of the Company's products; volatility of and assumptions regarding crude oil and natural gas prices; fluctuations in currency and interest rates; assumptions on which the Company's current guidance is based; economic conditions in the countries and regions in which the Company conducts business; political uncertainty, including actions of or against terrorists, insurgent groups or other conflict including conflict between states; industry capacity; ability of the Company to implement its business strategy, including exploration and development activities; impact of competition; the Company's defense of lawsuits; availability and cost of seismic, drilling and other equipment; ability of the Company and its subsidiaries to complete capital programs; the Company's and its subsidiaries' ability to secure adequate transportation for its products; unexpected disruptions or delays in the resumption of the mining, extracting or upgrading of the Company's bitumen products; potential delays or changes in plans with respect to exploration or development projects or capital expenditures; ability of the Company to attract the necessary labour required to build its thermal and oil sands mining projects; operating hazards and other difficulties inherent in the exploration for and production and sale of crude oil and natural gas and in mining, extracting or upgrading the Company's bitumen products; availability and cost of financing; the Company's and its subsidiaries' success of exploration and development activities and their ability to replace and expand crude oil and natural gas reserves; timing and success of integrating the business and operations of acquired companies; production levels; imprecision of reserve estimates and estimates of recoverable quantities of crude oil, natural gas and natural gas liquids ("NGLs") not currently classified as proved; actions by governmental authorities; government regulations and the expenditures required to comply with them (especially safety and environmental laws and regulations and the impact of climate change initiatives on capital and operating costs); asset retirement obligations; the adequacy of the Company's provision for taxes; and other circumstances affecting revenues and expenses. The Company's operations have been, and in the future may be, affected by political developments and by federal, provincial and local laws and regulations such as restrictions on production, changes in taxes, royalties and other amounts payable to governments or governmental agencies, price or gathering rate controls and environmental protection regulations. Should one or more of these risks or uncertainties materialize, or should any of the Company's assumptions prove incorrect, actual results may vary in material respects from those projected in the forward-looking statements. The impact of any one factor on a particular forward-looking statement is not determinable with certainty as such factors are dependent upon other factors, and the Company's course of action would depend upon its assessment of the future considering all information then available. For additional information refer to the "Risks and Uncertainties" section of this MD&A.

Readers are cautioned that the foregoing list of factors is not exhaustive. Unpredictable or unknown factors not discussed in this report could also have material adverse effects on forward-looking statements. Although the Company believes that the expectations conveyed by the forward-looking statements are reasonable based on information available to it on the date such forward-looking statements are made, no assurances can be given as to future results, levels of activity and achievements. All subsequent forward-looking statements, whether written or oral, attributable to the Company or persons acting on its behalf are expressly qualified in their entirety by these cautionary statements. Except as required by law, the Company assumes no obligation to update forward-looking statements, whether as a result of new information, future events or other factors, or the foregoing factors affecting this information, should circumstances or Management's estimates or opinions change.

Special Note Regarding Currency, Production and Reserves

In this document, all references to dollars refer to Canadian dollars unless otherwise stated. Reserves and production data are presented on a before royalties basis unless otherwise stated. In addition, reference is made to crude oil and natural gas in common units called barrel of oil equivalent (“boe”). A barrel of oil equivalent (“BOE”) is derived by converting six thousand cubic feet (“Mcf”) of natural gas to one barrel (“bbl”) of crude oil (6 Mcf:1 bbl). This conversion may be misleading, particularly if used in isolation, since the 6 Mcf:1 bbl ratio is based on an energy equivalency conversion method primarily applicable at the burner tip and does not represent a value equivalency at the wellhead. In comparing the value ratio using current crude oil prices relative to natural gas prices, the 6 Mcf:1 bbl conversion ratio may be misleading as an indication of value. In addition, for the purposes of this MD&A, crude oil is defined to include the following commodities: light & medium crude oil, primary heavy crude oil, Pelican Lake heavy crude oil, bitumen (thermal oil), and synthetic crude oil.

For the year ended December 31, 2011 the Company retained Independent Qualified Reserves Evaluators (“Evaluators”), Sproule Associates Limited and Sproule International Limited (together as “Sproule”) and GLJ Petroleum Consultants Ltd. (“GLJ”), to evaluate and review all of the Company’s proved and proved plus probable reserves with an effective date of December 31, 2011 and a preparation date of February 13, 2012. Sproule evaluated the North America and International crude oil, NGL and natural gas reserves. GLJ evaluated the Horizon SCO reserves. The evaluation and review was conducted in accordance with the standards contained in the Canadian Oil and Gas Evaluation Handbook (“COGE Handbook”) and disclosed in accordance with National Instrument 51-101 – Standards of Disclosure for Oil and Gas Activities (“NI 51-101”) requirements. The 2011 reserves disclosure is presented in accordance with Canadian reporting requirements using forecast prices and escalated costs. The recovery and reserves estimates of crude oil, NGL and natural gas reserves provided in this presentation are estimates only and there is no guarantee that the estimated reserves will be recovered. Actual crude oil, NGL and natural gas reserves may be greater than or less than the estimates provided.

Reserves estimates provided in this presentation are company gross, before royalties.

Resources Other Than Reserves

The contingent resources other than reserves (“resources”) estimates provided in this presentation are internally evaluated by qualified reserves evaluators in accordance with the COGE Handbook as directed by NI 51-101. No independent third party evaluation or audit was completed. Resources provided are best estimates as of December 31, 2011. The resources are evaluated using deterministic methods which represent the expected outcome with no optimism or conservatism.

Resources, as per the COGE Handbook definition, are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations using established technology or technology under development, but are not currently considered commercially viable due to one or more contingencies. There is no certainty that it will be commercially viable to produce any portion of these resources.

Due to the inherent differences in standards and requirements employed in the evaluation of reserves and contingent resources, the total volumes of reserves or resources are not to be considered indicative of total volumes that may actually be recovered and are provided for illustrative purposes only.

Petroleum, bitumen or natural gas initially-in-place volumes provided are discovered resources which include: production, reserves, contingent resources and unrecoverable volumes.

Special Note Regarding non-GAAP Financial Measures

This MD&A includes references to financial measures commonly used in the crude oil and natural gas industry, such as adjusted net earnings from operations, cash flow from operations, cash production costs and net asset value. These financial measures are not defined by International Financial Reporting Standards (“IFRS”) and therefore are referred to as non-GAAP measures. The non-GAAP measures used by the Company may not be comparable to similar measures presented by other companies. The Company uses these non-GAAP measures to evaluate its performance. The non-GAAP measures should not be considered an alternative to or more meaningful than net earnings, as determined in accordance with IFRS, as an indication of the Company’s performance. The non-GAAP measures adjusted net earnings from operations and cash flow from operations are reconciled to net earnings, as determined in accordance with IFRS, in the “Financial Highlights” section of this MD&A. The derivation of cash production costs is included in the “Operating Highlights – Oil Sands Mining and Upgrading” section of this MD&A. The Company also presents certain non-GAAP financial ratios and their derivation in the “Liquidity and Capital Resources” section of this MD&A.

Volumes shown are Company share before royalties unless otherwise stated.

The background of the slide is a grayscale photograph of an industrial refinery. It features several tall distillation columns, a network of pipes, and various structural elements. A solid blue horizontal band is positioned across the middle of the image, containing the main title.

THE FUTURE CLEARLY DEFINED

Coking.com[®]
MORE PRODUCTION - LESS RISK!

