

## **Disclaimer**

This Report, including the data and information contained in this Report, is provided to you on an “as is” and “as available” basis at the sole discretion of the Government of Alberta and subject to the terms and conditions of use below (the “Terms and Conditions”). The Government of Alberta has not verified this Report for accuracy and does not warrant the accuracy of, or make any other warranties or representations regarding, this Report. Furthermore, updates to this Report may not be made available. Your use of any of this Report is at your sole and absolute risk.

This Report is provided to the Government of Alberta, and the Government of Alberta has obtained a license or other authorization for use of the Reports, from:

Canadian Natural Upgrading Limited, Chevron Canada Limited and 1745844 Alberta Ltd., as owners, and Shell Canada Energy as operator, for the Quest Project

(collectively the “Project”)

Each member of the Project expressly disclaims any representation or warranty, express or implied, as to the accuracy or completeness of the material and information contained herein, and none of them shall have any liability, regardless of any negligence or fault, for any statements contained in, or for any omissions from, this Report. Under no circumstances shall the Government of Alberta or the Project be liable for any damages, claims, causes of action, losses, legal fees or expenses, or any other cost whatsoever arising out of the use of this Report or any part thereof or the use of any other data or information on this website.

## **Terms and Conditions of Use**

Except as indicated in these Terms and Conditions, this Report and any part thereof shall not be copied, reproduced, distributed, republished, downloaded, displayed, posted or transmitted in any form or by any means, without the prior written consent of the Government of Alberta and the Project.

The Government of Alberta’s intent in posting this Report is to make them available to the public for personal and non-commercial (educational) use. You may not use this Report for any other purpose. You may reproduce data and information in this Report subject to the following conditions:

- any disclaimers that appear in this Report shall be retained in their original form and applied to the data and information reproduced from this Report
- the data and information shall not be modified from its original form
- the Project shall be identified as the original source of the data and information, while this website shall be identified as the reference source, and
- the reproduction shall not be represented as an official version of the materials reproduced, nor as having been made in affiliation with or with the endorsement of the Government of Alberta or the Project

By accessing and using this Report, you agree to indemnify and hold the Government of Alberta and the Project, and their respective employees and agents, harmless from and against any and all claims, demands, actions and costs (including legal costs on a solicitor-client basis) arising out of any breach by you of these Terms and Conditions or otherwise arising out of your use or reproduction of the data and information in this Report.

Your access to and use of this Report is subject exclusively to these Terms and Conditions and any terms and conditions contained within the Report itself, all of which you shall comply with. You will not use this Report for any purpose that is unlawful or prohibited by these Terms and Conditions. You agree that any other use of this Report means you agree to be bound by these Terms and Conditions. These Terms and Conditions are subject to modification, and you agree to review them periodically for changes. If you do not accept these Terms and Conditions you agree to immediately stop accessing this Report and destroy all copies in your possession or control.

These Terms and Conditions may change at any time, and your continued use and reproduction of this Report following any changes shall be deemed to be your acceptance of such change.

If any of these Terms and Conditions should be determined to be invalid, illegal or unenforceable for any reason by any court of competent jurisdiction then the applicable provision shall be severed and the remaining provisions of these Terms and Conditions shall survive and remain in full force and effect and continue to be binding and enforceable.

These Terms and Conditions shall: (i) be governed by and construed in accordance with the laws of the province of Alberta and you hereby submit to the exclusive jurisdiction of the Alberta courts, and (ii) ensure to the benefit of, and be binding upon, the Government of Alberta and your respective successors and assigns.



## Controlled Document

Quest CCS Project

# Quest CO2 Capture Ratio Performance

|                                |                                     |
|--------------------------------|-------------------------------------|
| <b>Project</b>                 | Quest CCS Project                   |
| <b>Document Title</b>          | Quest CO2 Capture Ratio Performance |
| <b>Document Number</b>         |                                     |
| <b>Document Revision</b>       | 3                                   |
| <b>Document Status</b>         |                                     |
| <b>Document Type</b>           |                                     |
| <b>Control ID</b>              | New                                 |
| <b>Owner / Authors</b>         | Jordan Houtstra                     |
| <b>Issue Date</b>              | February 20, 2018                   |
| <b>Expiry Date</b>             | None                                |
| <b>ECCN</b>                    | None                                |
| <b>Security Classification</b> |                                     |
| <b>Disclosure</b>              | None                                |

*Revision History shown on next page*

## Revision History

| REVISION STATUS |                   |                                      | APPROVAL          |               |          |
|-----------------|-------------------|--------------------------------------|-------------------|---------------|----------|
| Rev.            | Date              | Description                          | Originator        | Reviewer      | Approver |
| 0               | February 21, 2016 | Issued for Annual Report Review      | Stephen Tessarolo | Wilfried Maas |          |
| 1               | March 21, 2016    | Issued for Annual Report             | Stephen Tessarolo |               |          |
| 2               | February 24, 2017 | Issued for 2016 Annual Report Review | Adella Domm       | Wilfried Maas |          |
| 3               | February 20, 2018 | Issued for 2017 Annual Report Review | Jordan Houtstra   | Wilfried Maas |          |
|                 |                   |                                      |                   |               |          |
|                 |                   |                                      |                   |               |          |
|                 |                   |                                      |                   |               |          |

## Signatures for this revision

| Date | Role | Name | Signature or electronic reference (email) |
|------|------|------|---|
|      |      |      |   |
|      |      |      |   |
|      |      |      |   |

## Summary

This document summarizes the CO<sub>2</sub> capture ratio performance of the Quest facility for the reporting period.

## Keywords

Quest, CCS, CO<sub>2</sub> capture ratio, CO<sub>2</sub> recovery

## DCAF Authorities

| Date | Role | Name     | Signature or electronic reference (email) |
|------|------|----------|---|
|      |      | Add name | Actual signature                          |
|      |      | Add name | Actual signature                          |
|      |      | Add name | Actual signature                          |

**TABLE OF CONTENTS**

1. CO2 CAPTURE RATIO INTRODUCTION .....4

2. 2017 PERFORMANCE.....4

|                          |  |                                 |
|--------------------------|--|---------------------------------|
| CO2 Capture Ratio Report |  | 2017 GoA Knowledge Share Report |
|--------------------------|--|---------------------------------|

## 1. CO<sub>2</sub> CAPTURE RATIO INTRODUCTION

This document provides the annual CO<sub>2</sub> capture ratio performance of the Quest CCS facility. The CO<sub>2</sub> capture ratio is defined as the percentage of CO<sub>2</sub> in the three HMU raw hydrogen streams that is removed in the amine absorbers (V-24118, V-24218, and V-44118), separated in the CO<sub>2</sub> stripper, compressed, and sent to the CO<sub>2</sub> pipeline for injection. The typical CO<sub>2</sub> content in the absorber feed gas (raw hydrogen stream) is between 16 and 18% by volume.

## 2. 2017 PERFORMANCE

The CO<sub>2</sub> capture ratio data has been provided on a daily basis, and reported as the combined CO<sub>2</sub> capture ratio for the three HMUs. The data for the reporting period was from January 1 through December 31, 2017. The average capture ratio for the reporting period was 82.6%. See Figure 1 below for the daily averaged data.

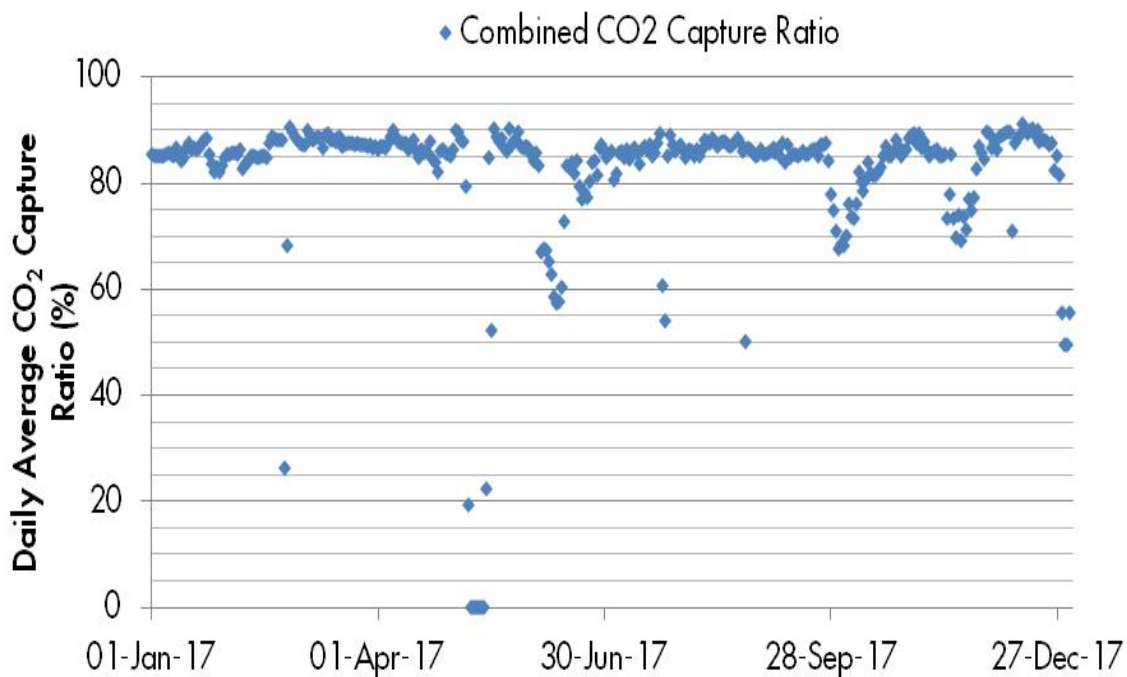


Figure 1: CO<sub>2</sub> Capture Ratio – Daily Averages

The data from Figure 1 shows that there were a few periods where performance on a daily basis was below the typical 80% capture ratio expected. The following events in 2017 contributed to these periods of reduced CO<sub>2</sub> capture ratio performance:

- February 23-24, 2017: A Power surge in the Cogeneration unit lead to a trip of the Amine charge pumps in the Quest capture unit.

- May 6-14 , 2017: Quest spring turnaround to complete a compressor inspection and exchanger cleaning.
- May 16, 2017: Quest compressor trip testing after implementing an MOC to re-rate the C-24701 compressor from 12MPa to 13.58MPa.
- June 5-23, 2017: HMU3 trip resulting in reduced hydrogen production. Prolonged start up activities at reduced capture was required to prove unit reliability which resulted in reduced overall capture ratio's.
- July 23-24, 2017: HMU3 restart after unplanned shutdown.
- August 25, 2017: Follow up Quest C-24701 compressor pinion inspection and lube oil nozzle replacement.
- September 28-October 11, 2017: Reduced hydrogen demand at the Upgrader resulted in turndown conditions in the Upgrader HMUs. When the HMUs go into turndown, capture ratios are reduced due to a low fuel gas pressure constraint. This constraint is a result of removing large volumes of CO<sub>2</sub> from the PSA feed streams via the absorbers, resulting in lower tail gas volumetric flowrates, and hence less pressure in the fuel gas piping to the reformer burners. Hydrogen plants are equipped with low fuel gas pressure differential trips as part of the safety system, so a minimum fuel gas pressure is maintained for reliability.
- November 13-24, 2017: RHC3/4 valve packing leak resulting in reduced hydrogen demand.
- November 13, 2017: Loss of amine circulation due to amine charge pump trip on low suction pressure.
- December 9, 2017: Loss of amine circulation due to amine charge pump trip on low suction pressure.
- December 29-31, 2017: Capture ratio was reduced to allow CO<sub>2</sub> back into the fuel gas system to increase fuel gas pressure and decrease the heating value. This was done to allow for better control of the firing system at low hydrogen production rates.

Overall, capture ratio performance was very strong for the year, sustaining ratios near 85% for the majority of the year outside of the periods listed above. This once again shows that the installed Quest technology/capacity is capable of strong, sustained CO<sub>2</sub> capture ratios with reliable performance and stable hydrogen demand.

|                          |  |                                 |
|--------------------------|--|---------------------------------|
| CO2 Capture Ratio Report |  | 2017 GoA Knowledge Share Report |
|--------------------------|--|---------------------------------|